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Project No. 1049-85

Project Title: Effective Integration of Achievement Measurement and Problem-Solving in Mathematics and Science Through Functional Subject Theories

Investigator(s): L.D. McLean

Date Initiated: 1987

Source of Funding: Transfer grant

Funding: $20,175.00

Attachments:

Thesaurus

Cooperative Learning, An Annotated Bibliography by Mary Rosser

Curriculum Development-Mathematics, An Annotated Bibliography by Mary Rosser

Curriculum Development-Science, An Annotated Bibliography

Strategies for Teaching Mathematics, An Annotated Bibliography by Mary Rosser

Problem Solving, An Annotated Bibliography by May Rosser

Systematic, Cumulative Records of Performance, An Annotated Bibliography by Mary Rosser

Structuralism/Functionalism, An Annotated Bibliography by Mary Rosser

From Comte to Structural Functionalism, An Essay by Mary Rosser

Curriculum Sequencing and Ordering: An Historical Overview by Mary Rosser

Summary of Task Group on Assessment and Tesing Report

North York Report on the Use of Writing Folders

Report on Education in Sweden and Denmark

Systematic, Cumulative Records of Achievement by Mary Rosser and Les McLean

The Inductive Curriculum-School Report

List of Problems to be Developed for Mathematics

A Curriculum for Cooperative Teaching and Learning

The Community Center Gets a Swimming Pool

Creating a School Bank

The Elevator System

Buying Food for the School Cafeteria

Teacher's Guide

Designing a Supermarket Display

Installing Solar Panels for the School

Teachers' Guide: Street Versus School Mathematics: Is There a Difference

Finding Out What's in Things

Project Document:

McLean, L.D. Effective Integration of Achievement Measurement and Problem-Solving in Mathematics and Science Through Functional Subject Theories. 1989. 3 pp. inc. attachments.

PROJECT REPORT

Progress Report: _____ Final Report: X Project Number: 1049.85

Small-Scale: _____ Large-Scale: X Funding Year: 87-88/88-89

Transfer Grant: X (Priority: #2) OISE: _____

New: ____ Continuing: X Terminated: X Re-funded: _____

Project Title: Effective Integration of Achievement Measurement and Problem-Solving in Mathematics and Science Through Functional Subject Theories

Investigator(s): L.D. McLean

Budget Unit: E.E.C. Date Rec'd in F&SR: Jn. 30/89

ABSTRACT

For large-scale projects, please provide in the space below an abstract of not more than 300 words, single-spaced, written in a language that may be understood by the informed layperson. For small-scale projects, an abstract per se may not be appropriate, and the report itself may be started below.

Effective integration of achievement measurement with problem solving is not only possible, it is highly desirable, especially in the middle school years. We found in this two-year project that mathematics, science and language could be integrated in a natural way by the use of *problem sets* that are meaningful to the students. Evaluation of achievement is based on a portfolio of completed work kept by each student. Most of the work on the problem sets is done in small groups (3 to 5 pupils), where the students work cooperatively. The integration with language happens naturally because language is necessary to make the problems meaningful. The link is exploited by having the students report on their work as well as writing up the results. The problem sets lend themselves to several modes of writing--narrative, persuasive and evaluative. The approach was most popular with grade 7 and 8 teachers who have large, heterogeneous classes for several subjects (who have to achieve a measure of integration in any case), but a small class that spends half its day working in French also reacted with enthusiasm. A few mathematics specialists looked at the materials, but they were not attracted by the integration.

The approach (problem sets, cooperative small groups, portfolio evaluation) is strongly supported by research, as documented in seven annotated bibliographies. These are organized by topic, from *Structuralism/Functionalism* to *Records of Achievement* (as portfolios are called in the United Kingdom). It was especially encouraging to find many studies supporting cooperative small groups, since this aspect emerged during the course of the project. Eight problem sets were developed (enough for a full school year), two with complete teacher's guide and student's version. A *General Introduction to the Methodology* has been prepared for teachers and curriculum consultants.

This project was funded by the Ministry of Education under its Block Transfer Grant to OISE

ON05863

Effective Integration of Achievement Measurement and Problem-Solving in Mathematics and Science through Functional Subject Theories

Description of Activities

In this second year of a two-year project, the activities were carried out as proposed:

1. The literature review from the first year was brought up to date and the theoretical paper revised. The guidelines were followed in extending the model over a full school year. It does not seem that separate papers should be written for science and mathematics teachers, but that will remain to be seen. An unexpected and welcome outcome was the effective integration of language teaching along with science and mathematics (see offprint of article from *McGill Journal of Education*, McLean 1988, attached).

2. Several background papers were prepared on aspects of the literature search (copies appended).

3. Nine problem sets were produced; three were fully completed with teacher's guides and were field tested. One of these was produced in two versions to learn whether teachers preferred one format over another. One has more of a science emphasis, having been produced by an Ontario science Department Head as part of the requirements for a Master of Education degree. (Copies are appended.)

4. Discussions were held with teachers and consultants in five Boards of Education (Durham, Peel, Metropolitan Separate, Toronto and York Region). Six teachers used the materials in their classes, two of them for more than two months. (See report appended, "The Inductive Curriculum--school report")

5. A videotape was prepared (ready in August 1989) to introduce the concepts of the inductive curriculum to teachers and show the use of the materials in actual classrooms.

Major Findings and Conclusions

In the three years since the project was conceived and proposed, widespread interest has emerged in all of its aspects. The emphasis on meaning and context is now appearing in just about every journal, especially as relevant to the teaching of problem-solving in mathematics and science (see, e.g., Schoenfeld, 1989; Brown, *et al.*, 1989). Research on cooperative small-group learning has been actively pursued for several years, but it began to receive general attention (see, e.g., Slavin, 1987; Ross, 1988). None of the research found to date, however, has attempted to implement all of the ideas with existing curriculum in ongoing classes. In particular, none of the research has addressed the problems of student evaluation, accountability and reporting to parents. A comprehensive favourable evaluation of portfolio evaluation has just been published (Broadfoot, *et al.*, 1988).

The main finding is that the approach is practical in virtually all types of Ontario middle school classrooms. It was welcomed especially by teachers who face large, heterogeneous classes to which they are expected to teach the core subjects of English, mathematics and science. Teachers specializing in mathematics appeared satisfied with their approach and uninterested in this variation. The *Inductive Curriculum* was immediately grasped and used in a small (20 student) French immersion Grade 7 for the half of their day in English. These bright students who had been together for several years

(and who got on well together), had no trouble with the "swimming pool" problem, which had proved too difficult for one Grade 8 class.

In the large, heterogeneous classes there are always (according to teacher reports) four or five students who refuse to work no matter what the teacher does. The inductive approach did not succeed in involving them either. The rest of the class did so well, however, that the teacher was enthusiastic, quickly deciding to hand the non-workers some old-fashioned worksheets which would be collected and marked. This, the teacher said, would ensure that these students did not disrupt the others and perhaps even did something of value. It struck the team as an impressive demonstration of the resourcefulness of classroom teachers and an indication that it was well worth pursuing the inductive approach.

To no one's surprise, the teachers can use the fully developed materials but rarely will have the time to develop their own sets, even with the start the project gives them. They did and will gather supplementary exercises, such as surveys from the newspapers for the set, *Making Sense of Opinion Polls*, and some teachers said they would work up a problem set in the summer if they were using the method. The main conclusion is that the project is not yet at the point where it can be recommended for a full school year. More interesting was the finding that teachers can integrate the inductive approach with their existing curriculum, which is didactic and deductive. From these few examples, one can estimate that the approach would be welcomed by at least half of the teachers in Ontario Grade 7 and Grade 8 classrooms. Although we had no direct experience, it seems clear that the approach would be at least as successful in Grade 9--especially if the decision is implemented to end tracking in Grade 9 (General and Advanced). Few Grade 6 classes could make good use of the existing problem sets (which were developed with Grade 8 in mind), but there seems no obstacle in principle to the approach in grades below 7.

References

Broadfoot, Patricia, James, Mary, McMeeking, Susan, Nuttall, Desmond & Stierer, Barry. (1988) *Records of Achievement: Report of the National Evaluation of Pilot Schemes.* London:Her Majesty's Stationery Office. (Order from HMSO Publications Centre, PO Box 276, London, SW8 5DT, or HMSO Bookshops.)

Brown, John Seely, Collins, Allan, & Duguid, Paul (1989) Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42. (See also two critiques and a rejoinder in *Educational Researcher, 18*(4), 5-12.

McLean, Les (1988) Achievement measures made relevant to pedagogy. *McGill Journal of Education, 23*(3), 243-252.

Ross, John A. (1988) Improving social-environmental studies problem solving through cooperative learning. *American Educational Research Journal, 25*(4), 573-591.

Schoenfeld, A. (1989) Ideas in the air: speculations on small group learning, environmental and cultural influences on cognition and epistemology. *International Journal of Educational Research,13*(10, 71-88.

Slavin, R. (1987) Cooperative learning and the cooperative school. *Educational Leadership, 45*(3), 7-13.

Thesaurus

for use with bibeffect bibliography

The following is a list of acronyms designed to capture the sense of the articles they describe. Beside each acronym is a full description of the category of information under discussion. The entries dealing with mathematics and curriculum are all US unless otherwise indicated. For example the addition of can means the information is Canadian e.g. matc K-6 can. Other countries are indicated in the same way e.g. matchd france.

coop	cooperation in education
curdev	curriculum development
curref	curriculum reform
curtheor	curriculum theory
matapp	mathematics applications
matcptm	mathematics curriculum-philosophies/theories/models
matchd	mathematics curriculum - history of development
matc K-6	mathematics curriculum the numbers appearing after the matc indicate the grade levels under discussion e.g. K-6, K-12, 7-9, etc.
mathtech	mathematics teaching - strategies for teaching mathematics
probsolv	problem solving articles primarily in the area of mathematics
profiles	folders/writing folders/records of achievement/portfolios
scied	science education (numbers after acronym denote grade levels)
scicptm	science curriculum-philosophies/theories/models
scicdev	science curriculum-development
scitech	science teaching - strategies for teaching science
strucfunc	structuralism/functionalism
teachtrn	training of teachers

All the articles referred to above are in the Effect_MR account on the VAX. The complete bibliography may be obtained by typing "bibeffect.mss" and having the file scribed and printed. A series of seven bibliographies using the same database has also been created. Each of the bibliographies contains articles that are related. e.g. articles on problem solving in bibprob.mss. Each .mss file must also be run through scribe and

printed in order to see the bibliography. The following is a list of the filenames and what they contain.

1. "bibcoop.mss": all the articles on cooperative learning,
2. "bibcurdevm.mss": all the articles relating to math curriculum
3. "bibicurdevsc.mss": all the articles that have *sci* in their acronym.
4. "bibmath.mss": all the articles on mathematics teaching
5. "bibprob.mss": all the articles on problem solving.
6. "bibprof.mss": all the articles on profiles
7. "bibstrucfunc.mss": structuralism/functionalism articles

Cooperative Learning

an annotated bibliography by Mary E. Rosser

Ames, C., & Ames, R. (1984). Systems of student and teacher motivation toward a qualititative definition. *Journal of Educational Psychology*, *76*(4), 535-556.

Three systems of motivation: ability-evaluative, task mastery and moral responsibility are defined. Each motivational system is seen as having a value orientation which teachers and students share. Student motivation is characterized by showing how each motivational system can be elicited by a cooperative, competitive or individualistic goal structure. Teacher motivation is characterized by showing how each system evolves from specific teacher goal orientations. The article examines how differing goals that affect student and teacher motivation are implicit in the goal structure of the classroom and in the teacher's belief system. coop.

Bain, D. (1988). The assessment of groupwork. *Mathematics in School*, *17*(1), 10-11.

The author has observed many group situations in the classroom. It is his opinion that group work improves motivation and should be encouraged in the mathematics classroom. How to group, how to assess group work and what tasks are most suitable are questions he asks but does not answer. coop.

Bejarano, Y. (1987). A cooperative small group methodology in the classroom. *Tesol Quarterly*, *21*(3), 483-504.

A doctoral dissertation comparing whole class teaching with each of two small group methodologies in the classroom: R. Slavin's Student Teams and Achievement Divisions (STAD) and Sharan and Lazarowitz's Discussion Groups (DG). The two methods are compared in a language learning situation. coop.

Bossert, S. (1979). *Tasks and social relationships in classrooms*. Cambridge : Cambridge University Press.

A report on the study of the implications of classroom organization for group relations. coop.

Brandt, R. (1987). On cooperation in schools: A conversation with David and Roger Johnson. *Educational Leadership*, *45*(3), 14-19.

David and Roger Johnson are presented with a number of questions about cooperative learning and their experiences with it. They believe that developing cooperative structures at all levels will contribute to the overall effectiveness of the method in the schools. They propose extending the involvement to include students, teachers, parents and administrators. coop.

Britton, J. (1976). *Language and learning*. London: Allan Lane.

A seminal work providing a sound theoretical rationale for emphasizing the importance of allowing students to learn through their own language and experience. coop.

Clarke, J., Wideman, R. & Eadie, S. (1988). *Together we learn: Co-operative small group learning with a focus on the Intermediate Division*. Toronto, ON: Metropolitan Toronto School Board.

The document resulted from the cooperation of writing teams from the Area Boards working in a collegial manner to produce curriculum materials involving the use of the small group concept. It was prepared for use in the school boards of Metropolitan Toronto with the focus on the Intermediate Division.

Davidson, N. (1985). Small group learning and teaching in mathematics . In R. Slavin, S. Sharan, S. Kagan, R. Lazarowitz, C. Webb & R. Schmuk (Eds.), *Learning to cooperate, cooperating to learn* (pp. 211-230). N.Y.: Plenum Press.

Davidson reviews a number of research projects which compare cooperative learning with individualistic learning. He discusses the attributes necessary to successful cooperative learning and the results obtained in a number of studies using different techniques and variables. The article also has a large bibliography. coop .

Gilbert-Macmillan, K. & Leitz, S. (1986). Cooperative small groups: A method for teaching problem solving. *Arithmetic Teacher, 33*(7), 9-11.

The authors found that children who are trained to work cooperatively in groups of 3-4 and who work within structured tasks have improved problem solving abilities. The children's thinking and insight was found to be stimulated by their interaction with other members of their group. A number of factors were found to influence the effectiveness of a group: size; perceived status of its members, both social and academic; and the method used to choose group members. coop probsolv.

Johnson, D. W. & Johnson, R. T. (1985). The internal dynamics of cooperative learning groups. In R. Slavin, S. Sharan, S. Kagan, R. Lazarowitz, C. Webb & R. Schmuck (Eds.), *Learning to cooperate, cooperating to learn* (pp. 103-124). N.Y.: Plenum Press.

This chapter presents a conceptual framework that includes eleven internal dynamics of cooperative learning groups that mediate or moderate the relation between cooperation and/or academic gains. These internal dynamics may be categorised as cognitive process variables, social variables and instructional variables.coop.

Johnson, D. W. & Johnson, R. T. (1983). The socialization and achievement crisis: Are cooperative learning experiences the solution. In L. Bickman (Ed.), *Applied Social Psychology Annual 4* (pp. 118-163). Beverly Hills, CA: Sage Publications

The authors conducted a study using three types of learning situation: cooperative, competitive and individualistic in a tightly controlled setting. The results of this study along with the results of similarly studies done by the authors and studies by other researchers in the field were subjected to a meta-analysis to test the theory that there is a positive relationship between proximity and interpersonal interaction on achievement and socialization. It was their conclusion that extensive use of competitive and individualistic learning structures in schools exacerbates alienation and lowers achievement. While cooperatively structured learning in school contributes to improved socialization and achievement. coop.

Johnson, D. W., & Johnson, R. T. (1987). Research shows the benefits of adult cooperation. *Educational Leadership, 45*(3), 27-30.

The authors look at summary finding of their meta-analysis of research comparing cooperative, competitive, and individualistic efforts by adults in 133 studies. coop .

Johnson, D. W., Johnson, R. T., Holubec, E. & Roy, P. (1984). *Circles of learning*. Englewood Cliffs, NJ: Prentice-Hall.

An excellent handbook designed to help educators understand what cooperative learning is, and procedures for implementing and supervising its use. coop.

Johnson, D. W., Johnson, R. T., & Maruyama, G. (1983). Interpendence and interpersonal attraction among heterogeneous and homogenous individuals: A theoretical formulation and meta-analysis of research . *Review of Educational Research, 53*(1), 5-54.

The meta-analysis produced the following results: a) cooperation without intergroup competition promoted greater interpersonal attraction for both the heterogeneous and homogenous groups than did interpersonal competition, individual efforts or cooperation with intergroup competition, b) cooperation with intergroup competition produced greater personal attraction among the participants than interpersonal competition or individual afforts, c) no significant differences were found between interpersonal competition and individual efforts in promoting interpersonal attraction amongst the participants. coop.

Johnson, D. W., Maruyama, G., Johnson, R.T., Nelson, D., & Skon, L. (1981). The effects of cooperative, competitive and individualistic goal structures on achievement. A meta-analysis and review. *Psychological Bulletin, 89*(1), 47-61.

The authors reviewed 122 studies comparing the relative effectiveness of cooperative, cooperative with intergroup competition, interpersonal competition and individualistic goal structures in promoting achievement and productivity in North American samples. Three meta analysis procedures were used: voting method, effect-size method and z-score method. The results indicated a) cooperation is considerably more effective than interpersonal and individualistic efforts, b) cooperation with intergroup competition is also superior to competition and individualistic effects, c) no significant difference was found between interpersonal competititive and individualistic efforts. coop.

Johnson, D. W., Skon, L. & Johnson, R. T. (1980). Effects of cooperative, competitive and individualistic conditions on children's problem solving performance. *American Educational Research Journal, 17*(1), 83-93.

The effects of interpersonal cooperation, competition, and individualistic efforts were compared on a categorization and retrieval, a spatial reasoning, and a verbal problem solving task. Forty-five first grade children were randomly assigned to conditions stratified on the basis of sex and ability so that an approximately equal percentage of males and females and high, medium and low ability children were included in each condition. The results indicate that on all three tasks students in the cooperative condition achieved higher than did those in the individualistic condition, and on two of the three tasks students in the cooperative condition achieved higher than did those in the competitive condition. There were no significant differences between the competitive and individualistic condition. Students in the cooperative condition used higher quality strategies on the three tasks than did those in the other two conditions, and they perceived higher levels of peer support and encouragement for learning. High ability students in the cooperative condition general achieved higher than did the high ability students in the competitive individualistic conditions. coop.

Johnson, R. T., Buckman, L. A., & Richards, P. S. (1985). The effect of prolonged implementation of cooperative learning on social support within the classroom. *Journal of Psychology, 119*(5), 405-411.

The study was conducted to determine whether cooperative learning experiences are related to social support in the classroom. The relation between social support and cooperative learning, the impact of prolonged implementation of cooperative learning on social support and the effect of different frequencies of cooperative learning experiences on social support in the classroom were inves-

tigated. Using a population of grade 8 students measurements of social support were taken in November and repeated in the following January. The results indicated that cooperative learning was highly related to social support in the classroom and that the longer and more frequently students engaged in cooperative learning, the greater the social support within the classroom became. coop.

Johnson, R.T., & Johnson, D. W. (1986). Comparison of computer assisted cooperative, competitive and individualistic learning. *American Educational Research, 23*(3), 382-392.

CAI cooperative, competitive and individual instruction are compared on achievement, student-student interaction and attitudes. The subjects were 74 eighth grade randomly assigned with each group balanced for sex and ability. CAI cooperative setting produced greater quantity and quality of achievement, more successful problem solving, more task related student-student interaction, and higher perceived status for female students. coop.

Kagan, S. (1985). Co-op Co-op: A flexible cooperative learning technique. In R. Slavin, S. Sharan, S. Kagan, R. Lazarowitz, C. Webb & R. Schmuk (Eds.), *Learning to cooperate, cooperating to learn* (pp. 437-452). N.Y.: Plenum Press.

The author describes the Co-op Co-op method of cooperative learning from the formation of groups through to spontaneous comments from students about their learning experiences in the group setting. coop.

Kagan, S. (1985). Dimensions of cooperative classroom structures. In R. Slavin, S. Sharan, S. Kagan, R. Lazarowitz, C. Webb & R. Schmuk (Eds.), *Learning to cooperate, cooperating to learn* (pp. 67-96). N.Y.: Plenum Press.

Six cooperative learning methods are discussed: STAD, TGT, Jigsaw (I and II), Group Investigation and Co-op Co-op. Each is analysed along 25 dimensions which fit into 6 categories: philosophies of education, nature of learning, nature of cooperation, student roles and communication, teacher roles, and evaluation. The chapter consists of three sections: a description of the methods used, an analysis of how the methods vary along the 25 dimensions, and a discussion of the implications of the analysis. coop .

Lesh, R. (1981). Applied mathematical problem solving. *Educational Studies in Mathematics, 12*(2), 235-264.

This paper presents a case for the importance of focusing on: (a)average ability students; (b)substantive mathematical content; (c)real problems; (d)realistic settings and solution procedures. Small group problem solving settings are suggested as a useful research context because of the expectation that effective instructional techniques for teaching applied mathematical problem solving processes may resemble some of the 'mathematics laboratory' activities to which the small group situation readily lends itself. The best of these laboratory activities makes it possible to concretize and externalize the ideas and processes that are linked in important conceptual models by promoting interactions with concrete materials (or lower order ideas) and interactions with other people. Suggestions were given about ways to modify existing applied problem solving materials so they will better suit the needs of both researchers and practitioners. mathtech, coop, probsolv.

Logan, T. (1986). Cooperative learning: A view from the inside. *The Social Studies, 77*(3), 123-126.

Group membership is not always seen as a positive attribute. The author discusses some of the reasons groups are viewed negatively by their participants:

simple personality clashes; arguments and lack of consensus within the group; over participation (dominance) or under participation by some members. To be successful, the group members must know exactly what they must do to earn a good evaluation. Teachers must encourage good group behavior by seeing that all members share responsibility for the task, that there is collective decision-making, fair distribution of speaking privileges and mutual assistance. coop.

Nijhoff, W. & Kommers, P. (1985). An analysis of cooperation in relation to cognitive controversy. In R. Slavin, S. Sharan, S. Kagan, R. Lazarowitz, C. Webb & R. Schmuck (Eds.), *Learning to cooperate, cooperating to learn* (pp. 125-145). N.Y. : Plenum Press.

This study focusses on an analysis of the cognitive functioning of the students within small groups. The research design involved pupils in a cooperative group task after they had each done the task individually. Thus, the group project involved equal individual input based on the prior experience of the problem by each pupil. Homogeneous and heterogeneous groups were formed. More arguments involving different knowledge and opinions was demonstrated by the heterogeneous group. The authors concluded that based on their literature search and their pilot study, there is insufficient knowledge of what goes on in group information processing but that prior knowledge is an important factor in problem solving.

Salmon, P. & Claire, H. (1984). *Classroom collaboration*. London: Routledge & Kegan Paul.

Research showing why students learn better by sharing and exchanging personal experiences related to the learning in a student centred classroom. coop.

Schoenfeld, A. (in press). Ideas in the air. *International Journal of Educational Research*.

In his own experimental work, the author has found that data can be viewed in many ways and that a group of people with varying backgrounds can enrich the interpretation of data when they collaborate. In the classroom, he sees group work as: enabling a teacher to coach students while they are engaged in semi-independent problem solving; helping students to develop the ability to monitor and evaluate their own development; and giving students the chance to collaborate in problem solving. Group work helps to relieve self-doubt as students realize that others in their group are also having difficulties understanding. coop.

Sharan, Y. & Sharan, S. (1987). Training teachers for cooperative learning. *Educational Leadership, 45*(3), 20-25.

Teachers learn about cooperative learning by taking part in cooperative learning settings themselves. By working with other teachers in a cooperative setting teachers learn to associate cooperative learning activities with the corresponding cooperative behaviors.coop.

Slavin, R. (1983). *Cooperative learning*. N.Y.: Longman.

This book is about alternatives to the traditional instruction system: cooperative learning methods. These are techniques that use cooperative task structures in which students spend most of their class time working in 4-6 member heterogeneous groups. They also use cooperative incentive structures in which students earn recognition, rewards or (occasionally) grades based on the academic performance of their groups. The theoretical basis for his cooperative learning systems along with methods based on the theory and results of evaluations of these methods are also presented. coop.

Slavin, R. (1985). An introduction to cooperative learning research. In E. Slavin, S. Sharan, S. Kagan, R. Lazarowitz. C. Webb & R. Schmuk (Eds.), *Learning to cooperate, cooperating to learn* (pp. 5-15). N.Y.: Plenum Press.

Cooperative learning is seen as a method which will encourage the low achiever and high achiever to work together for their general benefit. A number of methods used in cooperative learning are outlined as is the need for adequate methods for establishing accountability in and by the groups. Of particular importance is the positive effect cooperative learning has on race relations. coop.

Slavin, R., Sharan, S., Kagan, S., Lazarowitz, R., Webb, C. & Schmuck, R. (Eds.). (1985). *Learning to cooperate, cooperating to learn.* N.Y.: Plenum Press.

All the articles in this book were originally presented at the 2nd conference of the International Association for the Study of Cooperation in Education held at Brigham Young University, Provo, Utah, July 1982. The IASCE is a group of educators interested in studying, developing or applying cooperative methods at various levels of the process of education. It includes researchers, teacher educators, teachers and school administrators from a dozen countries. All the editors have at least one article in the book. Other authors include: Noreen Webb, David and Roger Johnson, Neil Davidson and others from the field. coop.

Slavin, R. (1987). Cooperative learning: Can students help students learn. *Instructor, 96*(7), 74-78.

Slavin reports on cooperative learning techniques he has developed that have reorganized classrooms into exciting high-achieving places. coop.

Slavin, R. (1987). Cooperative learning and the cooperative school. *Educational Leadership, 45*(3), 7-13.

Slavin discusses the growing trend to apply cooperative principles not only in classrooms but at the school level as well where teachers are involved in cooperative planning, peer coaching and team teaching with these activities directed toward effective implementation of cooperative learning in the classroom. He says "For cooperative learning to be effective and a positive experience for those involved the group product must be based on the sum of individual learning performances of all group members." coop .

Slavin, R. (1988). Cooperative learning and student achievement. *Educational Leadership, 46*(2), 31-33.

Slavin voices his concern that all forms of cooperative learning are being seen as equally capable of increasing student achievement and improving social relationships. In his opinion, for cooperative learning to be really effective two conditions are essential: 1) the cooperating groups must have a group goal and 2) the success of the group must depend on the individual learning of all group members. coop.

Slavin, R. (1987b). Cooperative learning and the cooperative school. *Educational Leadership, 45*(3), 7-13.

A discussion of cooperative learning in classrooms. The article also discusses the conditions under which cooperative learning is most effective. Two conditions are seen as essential: the students must be working towards a common goal and success at achieving this goal must depend on the individual learning of all group members. coop.

Torbe, M. & Medway, P. (1981). *The climate for learning.* London: Ward Lock Educa-

tional.

An exploration of contexts in which learning can take place in the classroom. A psycholinguistic rationale for learning through peer interaction. coop.

Wilkinson, L. C. (1988-1989). Grouping children for learning: Implications for KIndergarten education. In E. Z. Rothkopf (Ed.), *Review of research in education*. Washington,DC: AERA.

A survey of group learning from a sociological, sociolinguistic, process-product and cooperative learning standpoint. The article concludes that the research literature on instructional grouping is not complete enough to guide policy and practice. The primary interest of the author was the use of instructional groups in elementary school with a consideration of its kindergarten potential and how children might best be prepared to meet the demands of elementary school. coop.

Curriculum Development - Mathematics

an annotated bibliography by Mary E. Rosser

Bruner, J. (1971, September). The process of education revisited. *Phi Delta Kappan*, pp. 18-21.

Bruner looks in detail at 'The process of education', his earlier book, and compares his attitude towards education at that time which was primarily cognitive/psychological with his more current concerns with the welfare of mankind and the role the schools should be playing to further mankind's growth and to address the needs of society on all levels by providing educational opportunities for all whether handicapped physically, mentally, economically or socially. curdev matcptm.

Bruner, J. (1971). The relevance of skill or the skill of relevance. In *The relevance of education* (pp. 108-117). N.Y.,NY: Norton Press.

Bruner's view of curriculum development:"Proper curriculum requires statement of objectives...what skills are we trying to create and by what kinds of performance shall we know it....Students need to be involved in the setting of goals so that what is learned will have personal relevance and what is learned also needs social relevance." curdev matcptm.

Cambridge Institute of Education. (1985). *New perspectives on the mathematics curriculum: An independent appraisal of the outcomes of APU mathematics testing 1978-1982*. London: Her Majesty's Stationery Office.

A report dealing with the use of language by children in problem solving situations in which the researchers found that children did better when tested orally than on a written test; that personal motivation and appropriate context determined the level of performance by children. matcptm mathtech probsolv.

Crawford, D. H. (1970). Rethinking school mathematics 1959-present. In *A history of mathematics education in the United States and Canada* (pp. 426-450). National Council of Teachers of Mathematics 32nd yearbook.

curdev matchd.

Crawford, D. H. (1970). School mathematics in Ontario 1894-1959. Expansion and moderate reform. In *A history of mathematics education in the United States and Canada* (pp. 385-411). National Council of Teachers of Mathematics 32nd Yearbook.

curdev matchd.

Eisenberg, T. A. (1975). Behaviourism: The bane of school mathematics. *International Journal of Mathematics Education in Science and Technology*, *6*(2), 163-171.

This is a discussion of underlying philosophy and wide-spread use of behaviourism. It recommends that the model not be used in constructing mathematics curricula. Behaviourism is seen as more appropriate to training and is not appropriate to the discipline of mathematics. matcptm.

Fey, J. T. (1979). Mathematics teaching today: Perspectives from three national surveys. *Mathematics Teacher*, *72*(7), 490-504.

This article "is an attempt to synthesize the findings and to highlight the most provocative implications" of an impossing collection of six volumes. It describes..."findings of the literature review and the RTI survey, with selections from the case studies to elaborate on the picture". The areas covered include: 1.

Course content and enrollments 2. Patterns of instructional style 3. Teacher abilities, attitudes and beliefs 4. Changing school mathematics 5. The task ahead. In the section on the Task ahead: "But the most discouraging feature of the three NSF studies is the consistent pattern of great differences between apparent reality of mathematics education in most schools and the recommendations or practices of many prominent teachers, supervisors, and professional organizations". matc K-12.

Fletcher, T. J., Biehler, R., Hirstein, J., Jacobsen, E., Weinzweig, A. I. (1980). A framework for the discussion of the place of applications in the teaching of mathematics. In Steiner, H. G. (Ed.), *Comparative studies of mathematics curricula - Change and stability 1960-1980*. (pp. 654-659, 686-688). Bielefeld, FRG: Institut fur Didaktik der Mathematik der Universitat Bielefeld.

Fletcher et al use Howson's four dimensional curriculum model as a framework for discussing applications. "The four components: aims, methods, content, evaluation, form the basis of a taxonomy of issues that may help to define a role for applications in a school mathematics curriculum." matapp matchd.

Gray, R. F. (1979). The unstable arithmetic curriculum: Some perspectives and proposals for elementary school teachers. *Ontario Mathematics Gazette, 18*(1), 11-16.

A review of curriculum reform movements in mathematics from 1935-1970s. The author sees the Meaning Theory of the 50s and the Modern Mathematics of the 60s as complimentary and urges teachers to use them as such. curref matchd.

Greeno, J. G. (1985). Cognitive theory and curriculum design: A discussion of Thompson's paper. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 237-243). Hillsdale, NJ: Lawrence Erlbaum Associates.

Greeno discusses Thompson's contribution. He finds Thompson's combination of theoretical discussion and concrete instruction proposals a strong positive feature. He ties in Thompson's work with new developments in cognitive psychology using computational models that simulate performance in problem solving and reasoning. matcptm probsolv.

Halmos, P. R. (1980). The heart of mathematics. *The American Mathematical Monthly, 87*, 519-524.

Problems are seen as the heart of mathematics. The author emphasizes the need to train our students to be better problem posers and better problem solvers. curtheor matcptm probsolv.

Higginson, W. (1980). On the foundations of mathematics education. *For the learning of mathematics, 1*(2), 3-7.

The author presents a model for mathematics teaching based on the four disciplines: mathematics, philosophy, psychology and sociology = MAPS. matcptm.

Higginson, W. (1980). Research: Ideas of the 70s. *Mathematics Teaching, 90*, 5-8.

The most important ideas for development of mathematics curricula can be found in aspects of theories of Karl Popper, Imre Lakatos and Jean Piaget. To support his ideas Higginson quotes extensively from all three. Popper: "As we learn from our mistakes our knowledge grows." Lakatos:"...present mathematical and science education is a hotbed of authoritarianism and is the worst enemy of independent and critical thought." Piaget:"Knowledge is neither exclusively pre-existent nor solely environmentally determined....Learning is a self-sustaining

feedback loop." Popper and Piaget are both constructive and dialectical theorists. Lakatos continued the work of Popper. matcptm.

Hilton, P. (1984). Current trends in mathematics and future trends in mathematics education. *For the learning of mathematics*, *4*(1), 2-8.

This is a review of the dominant trends in mathematics education at primary and secondary levels and recommendations for changes in order to produce an integrated curriculum that stresses the interdependence of various parts of mathematics. matc K-12 can.

Hunter, J. & Cundy, M. (1978). *The mathematics curriculum. Number.* London: Blackie & Son, Limited.

The authors discuss the importance of problem solving in mathematics. It is their opinion that the most important thing to be learned in mathematics is how to tackle a problem and solve it. matcptm probsolv.

Kilpatrick, J. (1985). A retrospective account of the past 25 years of research on teaching mathematical problem solving. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 1-16). Hillsdale, NJ: Lawrence Erlbaum Associates.

He states that "no instructional program will succeed which does not deal with students' negative attitudes and beliefs about themselves as problem solvers." He also draws attention to the fact that research has not proved that facility with what he calls type 'd' problems... real problems... transfers out of school despite their apparent face validity. matchd mathtech probsolv.

McGarvey, C. (1981). Mathematics and miseducation: Toward the next school curricula. *Mathematics Teacher*, *74*(2), 90-95.

matchd.

Osborne, A. R. & Crosswhite, F. J. (1970). Emerging issues:1890-1920. In *A history of mathematics education in the United States and Canada* (pp. 155-297). National Council of Teachers of Mathematics 32nd Yearbook.

curdev matchd.

Robitaille, D. & Dirks, M. (1982). Models for mathematics curriculum. *For the learning of mathematics*, *2*(3), 3-21.

matcptm can.

Schoenfeld, A. H. (1985). Metacognitive and epistemological issues in mathematical understanding. In E. Silver (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 361-379). Hilsdale, NJ: Lawrence Erlbaum Associates.

This paper explores aspects of mathematical 'understanding' that extend beyond the mastery of routine facts and procedures. It deals with three aspects of such understanding which are viewed as of prime importance to problem solving. 1) Metacognitive skills and 'mathematical epistemology' are seen as essential components of competent mathematical performance. 2) Most students do not develop very many metacognitive skills or a mathematical epistemology to any degree. 3. Mathematical instruction focuses almost exclusively on mastery of facts and procedures rather than 'understanding'. Although difficult, the author feels it is possible to develop such skills in students. matcptm probsolv.

Scroggie, G. (1978). Intermediate division mathematics guideline. *Ontario Mathematics Gazette*, *17*(1), 30-32.

Discusses what should be in the curriculum but not the order in which it should be taught. matc 9-13 can.

Silver, E. (Ed.). (1985). *Teaching and learning mathematical problem solving: Multiple research perspectives*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Silver's book is a collection of writings by noted mathematicians and mathematics teachers. It deals with multiple research perspectives into the teaching of mathematics at all levels and is a good general resource book. matcptm probsolv.

Smith, R. S. (1981). Comment on the intermediate mathematics guideline. *Ontario Mathematics Gazette, 19*(3), 6-7.

The author says there is no philosophical base or rationale. matc 9-13 can matcptm.

Steiner, H. G. (1980). School curricula and the development of science and mathematics. *International Journal of Mathematics Education in Science and Technology, 11*(1), 97-106.

The development of different curricula: An historical overview. He quotes from Freudenthal "Social learning in school as a preparation for taking up responsibility and finding one's identity in the complex structures in our society, in which science plays a significant role, should thus be directly related to the science and mathematics curriculum itself." curdev matchd.

Steiner, H. G. (1985, June). Theory of mathematics education: An introduction. *For the learning of mathematics, 5*(2), 11-17.

The article deals with the different views of mathematics education as a science; the models used; and the attempts to develop a comprehensive approach to mathematics. matcptm.

Steiner, H. G. (1987). A systems approach to mathematics education. *Journal for Research in Mathematics Education, 18*(1), 46-52.

Deals with the phenomenon of complementarity which is seen as the cause of short-lived reforms. Pairs such as: skills vs. understanding; structure vs. problem solving; axiomatic vs. construction; or pure vs. applied represent attempts made historically to straighten out these paradoxes in a reductionist fashion by giving absolute dominion to one or other or by adopting a multi- aspect approach which suggests that doing both is the best approach. Neither approach understands and operationalizes the underlying antagonistic relationships and mutual interaction of any of the two positions. matcptm curref.

Thompson, P. W. (1985). Experience, problem solving and learning mathematics: Considerations in developing mathematics curricula. In E. Silver (Ed.). *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 189-236). Hillsdale, NJ: Lawrence Erlbaum Associates.

The purpose of Thompson's paper is to discuss an attempt at developing mathematics curricula that draws from research on problem solving and mathematical cognition, but goes beyond it in addressing issues unique to mathematics education. In his opinion, a collection of models of problem solving on relatively restricted problem sets is insufficient as a basis for designing a mathematics curriculum. matcptm probsolv.

Willoughby, S. S. (1981). *Teaching mathematics: What is basic?*. Washington, DC: Council for Basic Education.

Willoughby discusses the teaching of mathematics. He says "the most im-

portant reason for learning mathematics and for teaching it in the schools is that mathematics is, or ought to be useful." In order to test problem solving he suggest that: "the first step is to pick tests that evaluate all the underlying skills necessary for mathematical problem solving. Second, choose tests that include as much real problem solving as possible. Third, distrust the results of tests if there has been an obvious and concerted effort to prepare students to take the tests." matcptm probsolv.

Curriculum Development - Science

Abimbola, I. O. (1983, March). The relevance of the 'new' philosophy of science for the science curriculum. *School Science and Mathematics*, *83*, 181-193.

Abimbola looks at the works of philosophers in science and the progression through to a 'new' philosophy of science. Implications for science curriculum: knowledge of the philosophy of science will enable science teachers to understand the science they are teaching and this knowledge should affect their teaching because the knowledge, beliefs, and theories one holds determine what is perceived. The 'new' philosophers see science as a human activity which should be portrayed as such in the schools. Continuing research rather than accepted results is stressed by the 'new' philosophers of science. scied scidev.

Bybee, R. W. (1977, September). Towards a 3rd century of science education. *American Biology Teacher*, *39*(6), 338-341, 357.

Bybee sums up what has happened during the first two hundred years of science teaching in the US. 1. Very few of the changes recommended by individuals or committees have been implemented in science classes in the US. 2. A model where knowledge dominates continues. 3. The greatest changes have been at the elementary level, few at the secondary level. 4. The greatest changes have taken place in earth and environmental science; the least in biology, chemistry and physics. The classroom teacher was placed in the position of accepting a change without adequate explanation of its necessity. In other words, there was an absence of theory to give meaning to the new program. He makes the following proposals for science education in the future: 1.Curriculum materials and instructional techniques should be reformed starting at the elementary level and then secondary and tertiary. 2.Environmental, earth and biological sciences should be concentrated on. 3.Science concepts should be introduced: population growth, ecology, and economics. 4.Goals of personal development and problem solving should be increased. 5.Teaching should stress interpersonal and group dynamics. 6.The development of values and ethical choice should be stressed. 7.Effective implementation of new materials should be stressed. scied scicdev.

Connelly, F. M. (1970). The role of principles of enquiry in the conduct of enquiring and in curriculum development. *The Science Teacher*, *37*(9), 23-26.

A comparison of curricular statements on scientific method, a description of six very general characteristics of enquiry and general characteristics of knowledge claims. scicptm curdev.

Dowling, K. W. & Dowling, W. K. (1971). *The science curriculum and the states*. St. Louis, MO: Council of State Science Supervisors.

Operational definition for science education: Any series of related activities that develops an understanding of the conceptual structure and processes of science directed toward contributing to the student's ability to interpret science information and enable him to understand the role of science and its applications and limitations within society. "When facts with meaning for the learner are tied into a logically-related conceptual pattern, retention is improved and insight is more apt to occur. Understanding of conceptual structure allows students to choose what is pertinent in a new situation, learn at their own pace yet communicate with each other because they are working within the same conceptual scheme." "Coordination of conceptual and process structures in curriculum provide the route to greater complexity.... Science as a context for

general inquiry places science in a position of considerable importance in general education.... The adoption of the 'involvement' philosophy for science learning makes impossible the separation of process, cognitive and affective goals. These fundamentals of a science program are completely interwoven and intermingled" curdev scicdev scitech scicptm.

Gallagher, J. J. (1972). A summary of research in science education for the years 1968-1969. *Journal of Research in Science Teaching, 9*, 19-46.

a review covering research related to science instruction at the elementary school level. Criteria for inclusion in the bibliography were: significance of the question investigated, validity of research design, rigor of data interpretation and adequacy of reporting. scied K-6.

Hurd, P. D. (1970). Scientific enlightment for an age of science. *The Science Teacher, 37*(1), 13-15.

A statement about the reorganization of curriculum development in terms of a cultural context which represents a new viewpoint about the purposes for teaching science. scicptm.

Kerr, J. F. (1965). Science teaching and social change. *School Science Review, 47*, 301-309.

This article refers to old and new science courses and uses Nuffield as an example of one of the new ones. It attempts to look at some recent changes in science teaching....as the result of a complex interplay between educational and social forces. There is a plea for teachers to get involved in producing a theory of change in education. scied curref.

Lewis, D. G. (1965). Objectives in the teaching of science. *Educational Research, 7*, 186-189.

Review article on objectives of science teaching with emphasis on non-content matters. scicptm.

McGuire, F. J. (1967). Join in the scientific adventure. *Catholic School Journal, 67*, 42-45.

Describes a particular philosophy of science: moderate realism, and argues that it ought to be the basis for curriculum. scicptm.

Raven, R. J. (1970). Toward a philosophical basis for selecting curriculum content. *Curriculum Theory Network*, (4).

Argues for an epistemological approach in curriculum development. scicptm.

Schwab, J. J. (1962). The teaching of science as enquiry. In *The teaching of science* (pp. 3-103). Cambridge, MA: Harvard University Press.

Schwab develops and uses the distinction between "stable" and "fluid" enquiry in science. In response to the need for public support of science, he prescribes and gives a rationale for methods appropriate to teaching science as fluid enquiry. scicptm.

Slawson, W. S. (1968). Basis of science curriculum development in the future. *Science Teacher, 35*, 22-26.

Conceptual schemes vs. Big Ideas vs. Unifying Themes. Argues for establishing a coherent conceptual scheme of all the sciences as a basis for curriculum construction; a Platonic view of our state of scientific knowledge. scicptm curtheor.

Van Deventer, W. C. (1970, November). Evaluating students' understanding of ideas in junior high school science. *The Science Teacher*, pp. 51-54.

A study which attempts to measure scientific reasoning and understanding with the use of open-ended, idea-centered materials and experiences. scied.

Strategies for Teaching Mathematics

an annotated bibliography by Mary E. Rosser

Association of Teachers of Mathematics. (1977). *Notes on mathematics for children.* Cambridge, Eng.: Cambridge University Press.

Discusses different methods of teaching mathematics including problem solving. probsolv mathtech.

Cambridge Institute of Education. (1985). *New perspectives on the mathematics curriculum: An independent appraisal of the outcomes of APU mathematics testing 1978-1982.* London: Her Majesty's Stationery Office.

A report dealing with the use of language by children in problem solving situations in which the researchers found that children did better when tested orally than on a written test; that personal motivation and appropriate context determined the level of performance by children. matcptm mathtech probsolv.

Cherkas, B. (1978). The teacher as a role model in problem solving. *School Science and Mathematics, 78*(3), 193-196.

A discussion of the qualities and techniques the author has found helpful in creating a positive classroom environment for teaching problem solving, e.g. freehand drawing, modified Socratic method, differentiating math language from colloquial language. mathtech, probsolv.

Halmos, P. R. (1975). The teaching of problem solving. *American Mathematical Monthly, 82*(5), 466-470.

Halmos states that "what mathematics is really all about is solving concrete problems." He refers to Polya's famous dictum "if you can't solve a problem, then there is an easier problem that you can solve - find it!" In order to solve a problem it is necessary to ask questions. "Find the right question to ask and you're a long way toward solving the problem you are working on." Finding the right question means doing research. Teachers, he says, should be teaching research attitudes and in order to do that they must have had some experience doing research themselves and be able to use those experiences to teach their students. mathtech, probsolv, teachtrn.

Kilpatrick, J. (1978). Research on problem solving in mathematics. *School Science and Mathematics, 78*(3), 189-196.

A brief view of issues and developments in the field as a way of summarizing how far we still need to go in order to build a scholarly basis for teaching problem solving. probsolv mathtech.

Kilpatrick, J. (1985). A retrospective account of the past 25 years of research on teaching mathematical problem solving. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 1-16). Hillsdale, NJ: Lawrence Erlbaum Associates.

He states that "no instructional program will succeed which does not deal with students' negative attitudes and beliefs about themselves as problem solvers." He also draws attention to the fact that research has not proved that facility with what he calls type 'd' problems... real problems... transfers out of school despite their apparent face validity. matchd mathtech probsolv.

Lesh, R. (1981). Applied mathematical problem solving. *Educational Studies in Mathematics, 12*(2), 235-264.

This paper presents a case for the importance of focusing on: (a)average ability students; (b)substantive mathematical content; (c)real problems; (d)realistic settings and solution procedures. Small group problem solving settings are suggested as a useful research context because of the expectation that effective instructional techniques for teaching applied mathematical problem solving processes may resemble some of the 'mathematics laboratory' activities to which the small group situation readily lends itself. The best of these laboratory activities makes it possible to concretize and externalize the ideas and processes that are linked in important conceptual models by promoting interactions with concrete materials (or lower order ideas) and interactions with other people. Suggestions were given about ways to modify existing applied problem solving materials so they will better suit the needs of both researchers and practitioners. mathtech, coop, probsolv.

Lesh, E. & Landau, M. (Eds.). (1983). *Acquisition of mathematical concepts and processes*. N.Y., NY: Academic Press.

A collection of articles dealing with different areas of mathematics teaching including problem solving primarily at the college and higher levels. mathtech probsolv.

Mayer, R. E. (1985). Implications of cognitive psychology for instruction in mathematical problem solving. In Silver, E. A. (Ed.), *Teaching and learning mathematical problem solving: Multiple research prespectives* (pp. 123-138). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Four types of training to improve students' mathematical problem solving performance are presented.They are:

1. Translation training: comprehension versus solution...Let students draw pictures or move blocks to represent propositions. Ask students to rephrase propositions. Ask students to reword propositions into another context. Ask students to derive equations or number sentences for problem sentences.
2. Schema training:understanding versus executing...Mix problem types in exercises. Ask students to recognize problem types. Ask students to select relevant and irrelevant information. Ask students to draw or state a problem.
3. Strategy training: process versus product...Let students describe their solution strategies. Let students compare their solution process to that of 'experts' such as in worked-out examples. Provide direct instruction in strategies for specific problems.
4. Algorithm automaticity: procedures versus response...Provide practice in basic algorithms before moving to complex algorithms. Evaluate and remediate performance in algorithms in terms of bugs in subprocesses. curdev mathtech probsolv.

Pollak, H. O. (1978). On mathematics application and real problem solving. *School Science and Mathematics*, *78*(3), 232-247.

A discussion of the relationship between applications of mathematics and the teaching of mathematics is presented with an analysis of 'word' problems showing the positive and negative aspects of the problems used. For example 'real problems' that describe impossible situations are compared with practical everyday problems. A number of examples of the different types of 'real' problems are given in the article. mathtech, probsolv .

Polya, G. (1957). *Anchor Books. How to solve it* (2nd ed.). Garden City, NY: Doubleday & Co., Inc.

This is the 2nd edition of a 'classic' of mathematical problem solving. The

book consists of four parts: In the classroom; How to solve it: a dialogue; a short dictionary of heuristics (the major emphasis in the book) and finally a section with problems, hints and solutions. Polya reflects back on his own experiences in the classroom and quotes from them. mathtech, probsolv.

Polya, G. (1965). *Mathematical discovery: on understanding, learning and teaching problem solving*. N.Y. NY: John Wiley & Sons. Inc.

Volume 1: The aim of this work is to understand problem solving, to propose ways to teach it and to improve the problem solving ability of the reader. *Volume 2*: Polya proposes the addition of two points to the *Recommendation of the Mathematical Association of America for the Training of Mathematics Teachers*: 1. The training of teachers of mathematics should offer experience in independent (creative) work on the appropriate level in the form of a problem solving seminar or in other suitable form. 2. Methods courses should be offered only in close connection either with subject matter courses or with practice teaching and, if feasible, only by instructors experienced both in mathematical research and teaching." The index to the 2nd volume contains coded references to five volumes of his work: volumes 1 & 2 of *Mathematical Discovery*, *How to Solve it*, and volumes 1 & 2 of *Mathematics and Plausible Reasoning*. mathtech, probsolv, teachtrn .

Saxe,G. B. (1988). Candy selling and math learning. *Educational Researcher, 17*(6), 14-21.

The author investigates how children form mathematical understandings in their out-of-school activities. Using a multimethod study of Brazilian child candy sellers, he is able to show that sellers with little or no formal education can use complex mathematics in their negotiations with their suppliers and their clients and can carry over some of their skills to school mathematics. mathtech.

Saxe, G. B. (1988). The interplay between children's learning in school and out-of-school contexts. In M. Gardner, J. Greeno, F. Reis & A. Schoenfeld (Eds.), *Toward a scientific practice of science education*. Hillsdale, NJ: Erlbaum.

Originally presented at a conference sponsored by the Lawrence Hall of Science & Graduate School of Education, University of California, Berkeley,and Institute for Research on Learning, Xerox Palo Alto Research Center, Jan. 1988 This paper looks at the results of a study of children in Brazil and their ability to perform complex mathematic tasks with little if any formal education . mathtech.

Saxe, G. B. (1988). The mathematics of child street vendors. *Child Development, 59*, 1415-1425.

A comparative study of three groups of children 10-12 years of age: a group of urban candy sellers, and two groups of non-sellers; one urban and the other rural. All the children had developed non-standard means of representing large numerical values. The candy sellers had developed strategies for solving arithmetical and ratio problems. The findings are interpreted as supporting a model of cognitive development in which children construct novel understandings as they address problems that emerge in their everyday cultural practices. mathtech.

Schoenfeld, A. H. (1983). *Problem solving in the mathematics curriculum* (Tech. Rep.). The Mathematical Association of America Committee on Teaching of Undergraduate Mathematics.

Schoenfeld says that what seems simple to the teacher is often incomprehensible to the student. Teachers need to analyse their own thinking to get at all the steps necessary to the resolution of the problem. The teacher should <u>not</u> generate

solutions...but help the students to use the resources they have to solve the problem. This book has an exceptional bibliography. mathtech probsolv.

Schoenfeld, A. H. (1983, March). The wild, wild, wild, wild, wild world of problem solving (A review of sorts). *For the learning of mathematics*, *3*(3), 40-47.

The author says that while we are making progress in understanding problem solving, we still have much to do. He is concerned that there will be societal pressures forcing mathematics curriculum into a 'back to back to basics' strategy. He distinguishes a problem from an exercise. An exercise is something that can be solved using routine or familiar techniques. A problem is only a problem when you do not know how to go about solving it and you want to solve it. mathtech probsolv.

Schoenfeld, A. H. (1985). *Mathematical problem solving*. Orlando, FL: Academic Press, Inc.

This book is the summary of ten years of effort by the author to understand and teach mathematical problem solving skills. His strategies are similar to those of Polya. He looks at two major questions: What does it mean to think mathematically? and How can we teach students to do it? mathtech, probsolv. teachtrn.

Sowder, L. (1985). Cognitive psychology and mathematical problem solving: A discussion of Mayer's paper.. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research prspectives* (pp. 139-145). Hilldsale, NJ: Lawrence Erlbaum Associates.

Sowder discusses in detail a paper by R. E. Mayer which discusses training students to be problem solvers by using a series of model problems. He disagrees with many of Mayer's proposals. He questions whether it is possible to teach a strategy of reflection for both before and after the solution of a problem. Mayer proposes teaching how to translate what a problem is about by representing it with a diagram. mathtech probsolv.

Tobias, S. (1987). *Succeed with math*. N.Y.NY: College Board.

Chapter three: Problem solving is seen as very individual. "What works for one problem solver may not work for another. What works in one type of problem may not work in another." The chapter aims to help the reader develop problem solving strategies based on solving puzzles. mathtech, probsolv.

Tuma. D. T. & Rief, F. (1980). *Problem solving and education: Issues in teaching and research*. Hillsdale, NJ: Lawrence Erlbaum Associates.

A collection of conference papers from the *Problem Solving in Education: Issues in Teaching and Research* conference held at Carnegie-Mellon University October 1978 which deal with basic research on problem solving and its relevance to education and practical attempts designed to teach students improved problem solving skills. mathtech, probsolv.

Webb, L. F. & Ost, D. H. (1978). Real comprehensive problem solving as it relates to mathematics teaching in the secondary schools. *School Science and Mathematics*, *78*(3), 197-206.

In the authors' opinion: contrived problems selected by the teacher are not real for most students and the result is lack of interest on the part of students, no motivation to pursue the tasks beyond the formal requirements and no increased appreciation of the uses of learning. For a problem to be real, they say an individual must be able to identify it as a problem for which a solution is possible.

Real comprehensive problem solving (their term) as distinguised from generalized problem solving, involves not merely a problem orientation in some specific subject area; it crosses any number of disciplines and focuses upon a real problem. They recommend that RCPS be made an important part of any school program. curdev, mathtech, probsolv.

Whimbey, A. & Lochhead, J. (1979). *Problem solving and comprehension, A short course in analytical reasoning*. Philadelphia, PA: Franklin Institute Press.

Remedial problems are addressed by focussing on the problem solving process. The program is designed to be used by people working in pairs or groups. It encourages the discussion and exchange of ideas. mathtech, probsolv.

Problem Solving

an annotated bibliography by Mary E. Rosser

Association of Teachers of Mathematics. (1977). *Notes on mathematics for children.* Cambridge, Eng.: Cambridge University Press.

Discusses different methods of teaching mathematics including problem solving. probsolv mathtech.

Cambridge Institute of Education. (1985). *New perspectives on the mathematics curriculum: An independent appraisal of the outcomes of APU mathematics testing 1978-1982.* London: Her Majesty's Stationery Office.

A report dealing with the use of language by children in problem solving situations in which the researchers found that children did better when tested orally than on a written test; that personal motivation and appropriate context determined the level of performance by children. matcptm mathtech probsolv.

Cherkas, B. (1978). The teacher as a role model in problem solving. *School Science and Mathematics, 78*(3), 193-196.

A discussion of the qualities and techniques the author has found helpful in creating a positive classroom environment for teaching problem solving, e.g. freehand drawing, modified Socratic method, differentiating math language from colloquial language. mathtech, probsolv.

Gilbert-Macmillan, K. & Leitz, S. (1986). Cooperative small groups: A method for teaching problem solving. *Arithmetic Teacher, 33*(7), 9-11.

The authors found that children who are trained to work cooperatively in groups of 3-4 and who work within structured tasks have improved problem solving abilities. The children's thinking and insight was found to be stimulated by their interaction with other members of their group. A number of factors were found to influence the effectiveness of a group: size; perceived status of its members, both social and academic; and the method used to choose group members. coop probsolv.

Greeno, J. G. (1985). Cognitive theory and curriculum design: A discussion of Thompson's paper. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 237-243). Hillsdale, NJ: Lawrence Erlbaum Associates.

Greeno discusses Thompson's contribution. He finds Thompson's combination of theoretical discussion and concrete instruction proposals a strong positive feature. He ties in Thompson's work with new developments in cognitive psychology using computational models that simulate performance in problem solving and reasoning. matcptm probsolv.

Halmos, P. R. (1975). The teaching of problem solving. *American Mathematical Monthly, 82*(5), 466-470.

Halmos states that "what mathematics is really all about is solving concrete problems." He refers to Polya's famous dictum "if you can't solve a problem, then there is an easier problem that you can solve - find it!" In order to solve a problem it is necessary to ask questions. "Find the right question to ask and you're a long way toward solving the problem you are working on." Finding the right question means doing research. Teachers, he says, should be teaching research attitudes and in order to do that they must have had some experience doing research themselves and be able to use those experiences to teach their students. mathtech, probsolv, teachtrn.

Halmos, P. R. (1980). The heart of mathematics. *The American Mathematical Monthly, 87*, 519-524.

Problems are seen as the heart of mathematics. The author emphasizes the need to train our students to be better problem posers and better problem solvers. curtheor matcptm probsolv.

Hill, C.C. (1979). *Problem solving: Learning and teaching*. London: Frances Pinter (Publishers) Ltd.

This book is a collection of more than 250 different references from the problem solving literature. Each reference has an extensive annotation and all the references have been categorized into sections. There are sections on: developmental psychologists, stimulus-response theorists, gestalists, how problem solving is used to teach subject matter, etc. Each section begins with a general discussion of the area of problem solving the articles cover. probsolv.

Hunter, J. & Cundy, M. (1978). *The mathematics curriculum. Number.* London: Blackie & Son, Limited.

The authors discuss the importance of problem solving in mathematics. It is their opinion that the most important thing to be learned in mathematics is how to tackle a problem and solve it. matcptm probsolv.

Kilpatrick, J. (1978). Research on problem solving in mathematics. *School Science and Mathematics, 78*(3), 189-196.

A brief view of issues and developments in the field as a way of summarizing how far we still need to go in order to build a scholarly basis for teaching problem solving. probsolv mathtech.

Kilpatrick, J. (1985). A retrospective account of the past 25 years of research on teaching mathematical problem solving. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 1-16). Hillsdale, NJ: Lawrence Erlbaum Associates.

He states that "no instructional program will succeed which does not deal with students' negative attitudes and beliefs about themselves as problem solvers." He also draws attention to the fact that research has not proved that facility with what he calls type 'd' problems... real problems... transfers out of school despite their apparent face validity. matchd mathtech probsolv.

Lenchner, G. (1983). *Creative problem solving in school mathematics.* Boston, MA: Houghton Mifflin Co.

A problem solving handbook for elementary and middle school teachers which grew out of an inservice course for teachers. The teachers found that if they approached a problem creatively they could arouse the interest and curiosity of their students. probsolv.

Lesh, R. (1981). Applied mathematical problem solving. *Educational Studies in Mathematics, 12*(2), 235-264.

This paper presents a case for the importance of focusing on: (a)average ability students; (b)substantive mathematical content; (c)real problems; (d)realistic settings and solution procedures. Small group problem solving settings are suggested as a useful research context because of the expectation that effective instructional techniques for teaching applied mathematical problem solving processes may resemble some of the 'mathematics laboratory' activities to which the small group situation readily lends itself. The best of these laboratory activities makes it possible to concretize and externalize the ideas and processes that

are linked in important conceptual models by promoting interactions with concrete materials (or lower order ideas) and interactions with other people. Suggestions were given about ways to modify existing applied problem solving materials so they will better suit the needs of both researchers and practitioners. mathtech, coop, probsolv.

Lesh, E. & Landau, M. (Eds.). (1983). *Acquisition of mathematical concepts and processes*. N.Y., NY: Academic Press.

A collection of articles dealing with different areas of mathematics teaching including problem solving primarily at the college and higher levels. mathtech probsolv.

Mason, J., Burton, L., & Stacey, K. (1982). *Thinking mathematically*. London: Addison-Wesley Publishers Limited.

A look at a variety of means of problem solving. All are presented in a rather whimsical way with eye-catching cartoons accompanying serious text. probsolv.

Mayer, R. E. (1985). Implications of cognitive psychology for instruction in mathematical problem solving. In Silver, E. A. (Ed.), *Teaching and learning mathematical problem solving: Multiple research prespectives* (pp. 123-138). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Four types of training to improve students' mathematical problem solving performance are presented.They are:

1. Translation training: comprehension versus solution...Let students draw pictures or move blocks to represent propositions. Ask students to rephrase propositions. Ask students to reword propositions into another context. Ask students to derive equations or number sentences for problem sentences.
2. Schema training:understanding versus executing...Mix problem types in exercises. Ask students to recognize problem types. Ask students to select relevant and irrelevant information. Ask students to draw or state a problem.
3. Strategy training: process versus product...Let students describe their solution strategies. Let students compare their solution process to that of 'experts' such as in worked-out examples. Provide direct instruction in strategies for specific problems.
4. Algorithm automaticity: procedures versus response...Provide practice in basic algorithms before moving to complex algorithms. Evaluate and remediate performance in algorithms in terms of bugs in subprocesses. curdev mathtech probsolv.

Pollak, H. O. (1978). On mathematics application and real problem solving. *School Science and Mathematics*, *78*(3), 232-247.

A discussion of the relationship between applications of mathematics and the teaching of mathematics is presented with an analysis of 'word' problems showing the positive and negative aspects of the problems used. For example 'real problems' that describe impossible situations are compared with practical everyday problems. A number of examples of the different types of 'real' problems are given in the article. mathtech, probsolv .

Polya, G. (1957). *Anchor Books. How to solve it* (2nd ed.). Garden City, NY: Doubleday & Co., Inc.

This is the 2nd edition of a 'classic' of mathematical problem solving. The book consists of four parts: In the classroom; How to solve it: a dialogue; a short dictionary of heuristics (the major emphasis in the book) and finally a section with problems, hints and solutions. Polya reflects back on his own experiences in the classroom and quotes from them. mathtech, probsolv.

Polya, G. (1965). *Mathematical discovery: on understanding, learning and teaching problem solving*. N.Y. NY: John Wiley & Sons, Inc.

Volume 1: The aim of this work is to understand problem solving, to propose ways to teach it and to improve the problem solving ability of the reader. *Volume 2*: Polya proposes the addition of two points to the *Recommendation of the Mathematical Association of America for the Training of Mathematics Teachers*: 1. The training of teachers of mathematics should offer experience in independent (creative) work on the appropriate level in the form of a problem solving seminar or in other suitable form. 2. Methods courses should be offered only in close connection either with subject matter courses or with practice teaching and, if feasible, only by instructors experienced both in mathematical research and teaching." The index to the 2nd volume contains coded references to five volumes of his work: volumes 1 & 2 of *Mathematical Discovery*, *How to Solve it*, and volumes 1 & 2 of *Mathematics and Plausible Reasoning*. mathtech, probsolv, teachtrn .

Rubinstein, M. F. (1975). *Patterns of problem solving*. Englewood Cliffs, NJ: Prentice-Hall.

A textbook of problem solving. The book attempts to provide the reader with tools and concepts which will prove productive in problem solving.probsolv.

Schoenfeld, A. H. (1983). *Problem solving in the mathematics curriculum* (Tech. Rep.). The Mathematical Association of America Committee on Teaching of Undergraduate Mathematics.

Schoenfeld says that what seems simple to the teacher is often incomprehensible to the student. Teachers need to analyse their own thinking to get at all the steps necessary to the resolution of the problem. The teacher should not generate solutions...but help the students to use the resources they have to solve the problem. This book has an exceptional bibliography. mathtech probsolv.

Schoenfeld, A. H. (1983, March). The wild, wild, wild, wild, wild world of problem solving (A review of sorts). *For the learning of mathematics*, *3*(3), 40-47.

The author says that while we are making progress in understanding problem solving, we still have much to do. He is concerned that there will be societal pressures forcing mathematics curriculum into a 'back to back to basics' strategy. He distinguishes a problem from an exercise. An exercise is something that can be solved using routine or familiar techniques. A problem is only a problem when you do not know how to go about solving it and you want to solve it. mathtech probsolv.

Schoenfeld, A. H. (1985). *Mathematical problem solving*. Orlando, FL: Academic Press, Inc.

This book is the summary of ten years of effort by the author to understand and teach mathematical problem solving skills. His strategies are similar to those of Polya. He looks at two major questions: What does it mean to think mathematically? and How can we teach students to do it? mathtech, probsolv. teachtrn.

Schoenfeld, A. H. (1985). Metacognitive and epistemological issues in mathematical understanding. In E. Silver (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 361-379). Hilsdale, NJ: Lawrence Erlbaum Associates.

This paper explores aspects of mathematical 'understanding' that extend beyond the mastery of routine facts and procedures. It deals with three aspects of

such understanding which are viewed as of prime importance to problem solving. 1) Metacognitive skills and 'mathematical epistemology' are seen as essential components of competent mathematical performance. 2) Most students do not develop very many metacognitive skills or a mathematical epistemology to any degree. 3. Mathematical instruction focuses almost exclusively on mastery of facts and procedures rather than 'understanding'. Although difficult, the author feels it is possible to develop such skills in students. matcptm probsolv.

Silver, E. (Ed.). (1985). *Teaching and learning mathematical problem solving: Multiple research perspectives*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Silver's book is a collection of writings by noted mathematicians and mathematics teachers. It deals with multiple research perspectives into the teaching of mathematics at all levels and is a good general resource book. matcptm probsolv.

Sowder, L. (1985). Cognitive psychology and mathematical problem solving: A discussion of Mayer's paper.. In Silver, E. (Ed.), *Teaching and learning mathematical problem solving: Multiple research prspectives* (pp. 139-145). Hilldsale, NJ: Lawrence Erlbaum Associates.

Sowder discusses in detail a paper by R. E. Mayer which discusses training students to be problem solvers by using a series of model problems. He disagrees with many of Mayer's proposals. He questions whether it is possible to teach a strategy of reflection for both before and after the solution of a problem. Mayer proposes teaching how to translate what a problem is about by representing it with a diagram. mathtech probsolv.

Steinhaus, H. (1964). *One hundred problems in elementary mathematics*. N.Y. NY: Dover.

Considered on of the classic books dealing with problem solving both in the presentation of problems and their resolution. probsolv.

Thompson, P. W. (1985). Experience, problem solving and learning mathematics: Considerations in developing mathematics curricula. In E. Silver (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives* (pp. 189-236). Hillsdale, NJ: Lawrence Erlbaum Associates.

The purpose of Thompson's paper is to discuss an attempt at developing mathematics curricula that draws from research on problem solving and mathematical cognition, but goes beyond it in addressing issues unique to mathematics education. In his opinion, a collection of models of problem solving on relatively restricted problem sets is insufficient as a basis for designing a mathematics curriculum. matcptm probsolv.

Tobias, S. (1987). *Succeed with math*. N.Y.NY: College Board.

Chapter three: Problem solving is seen as very individual. "What works for one problem solver may not work for another. What works in one type of problem may not work in another." The chapter aims to help the reader develop problem solving strategies based on solving puzzles. mathtech, probsolv.

Tuma. D. T. & Rief, F. (1980). *Problem solving and education: Issues in teaching and research*. Hillsdale, NJ: Lawrence Erlbaum Associates.

A collection of conference papers from the *Problem Solving in Education: Issues in Teaching and Research* conference held at Carnegie-Mellon University October 1978 which deal with basic research on problem solving and its relevance to education and practical attempts designed to teach students improved problem solving skills. mathtech, probsolv.

Webb, L. F. & Ost, D. H. (1978). Real comprehensive problem solving as it relates to mathematics teaching in the secondary schools. *School Science and Mathematics, 78*(3), 197-206.

In the authors' opinion: contrived problems selected by the teacher are not real for most students and the result is lack of interest on the part of students, no motivation to pursue the tasks beyond the formal requirements and no increased appreciation of the uses of learning. For a problem to be real, they say an individual must be able to identify it as a problem for which a solution is possible. *Real comprehensive problem solving* (their term) as distinguised from generalized problem solving, involves not merely a problem orientation in some specific subject area; it crosses any number of disciplines and focuses upon a real problem. They recommend that RCPS be made an important part of any school program. curdev, mathtech, probsolv.

Whimbey, A. & Lochhead, J. (1979). *Problem solving and comprehension, A short course in analytical reasoning.* Philadelphia, PA: Franklin Institute Press.

Remedial problems are addressed by focussing on the problem solving process. The program is designed to be used by people working in pairs or groups. It encourages the discussion and exchange of ideas. mathtech, probsolv.

Whimbey, A. & Lochhead, J. (1984). *Beyond problem solving and comprehension: An exploration of quantitative reasoning.* Philadelphia, PA: The Franklin Institute Press.

This book has some 'real' problem solving examples. All are well presented with extensive resolutions of the problems. Some of the best problems are in section IV, "Interpreting graphs and tables" probsolv.

Whimby, A. & Lochhead, J. (1980). *Problem solving and comprehension. A short course in analytical reasoning.* Philadelphia, PA: The Franklin Institute Press.

A variety of problem solving methods are presented with actual problems to be solved. Detailed analyses are presented with discussions of appropriat methods to use in resolving particular problems. probsolv.

White, E. P. (1978). Problem solving: Its history as a focus in curriculum development. *School Science and Mathematics, 78*(3), 183-206.

The primary intention of this paper is to trace the historical development of problem solving as a curriculum goal with the hope that those who value problem solving as a major focus of education will notice the similarities and differences between what is now proposed and what has been done in the past and that they will benefit from the reflection. curdev, probsolv.

Willoughby, S. S. (1981). *Teaching mathematics: What is basic?.* Washington, DC: Council for Basic Education.

Willoughby discusses the teaching of mathematics. He says "the most important reason for learning mathematics and for teaching it in the schools is that mathematics is, or ought to be useful." In order to test problem solving he suggest that: "the first step is to pick tests that evaluate all the underlying skills necessary for mathematical problem solving. Second, choose tests that include as much real problem solving as possible. Third, distrust the results of tests if there has been an obvious and concerted effort to prepare students to take the tests." matcptm probsolv.

Systematic, Cumulative Records of Performance

an annotated bibliography by Mary E. Rosser

Adams, E. & Burgess, T. (1980). Conclusions and proposals. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 163-181). London: Macmillan Education Ltd.

The authors argue that on reaching the age of 16 every young person should have something substantial to show for years of compulsory education: a statement of experience, competence, interests and purposes, to show parents and employers alike. They offer a suggestion for the kind of system that might be set up in a school, together with the arrangements that could be made for gaining public recognition and support. National arrangements through which each school's procedures could be given a national currency are outlined. The proposals are practical and include the kind of organisation which would accommodate such questions as the role of subject specialisms, the individual tutor, the organisation of the school day and staff/student ratios. profiles.

Black, H. (1980). The forms and functions of assessment. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 90-103). London: Macmillan Education Ltd.

A distinction is made between summative assessment as a means of satisfying the informational needs of the society (parents, employers and institutions of further learning) and formative assessment as a help in learning and teaching. It is the author's opinion that summative needs to take account of a wider range of student attainment and formative needs more focus and systemisation of good teaching practices. Formative assessment to be useful needs to be continuous. The potential of the student to assess and record his/her own progress is undervalued. A profiling system is seen as a possible way of providing the information needed. profiles.

Black, H., & Broadfoot, P. (1982). *Keeping track of teaching*. London: Routledge & Kegan Paul Ltd.

This book is about assessment as part of teaching. Its aim is to help teachers develop and use assessment procedures (profiles) which are an integral and essential part of the teaching/learning process. Case studies are presented of different assessment techniques used in different school settings ranging from a junior school through to a community school. Diagnostic assessment is used in each case though there is variety in what makes up the assessment instrument. For example, in the community school where adults make up most of the population, the assessments are of a non-cognitive nature to ensure a non-threatening setting. In the junior school the assessment is child-centred, criterion referenced and includes pupil self assessment. The need to create forms of assessment which communicate clearly and effectively to the outside world (parents, other educational institutions and employers) is emphasized. profiles .

Blanchard, J. (1980). English at Comberton Village College. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 17-29). London: Macmillan Education Ltd.

In an expanding school the English Department needed to improve its monitoring of student progress. Tackling first the reports sent to parents, it advanced to making reports to each student. Next, students were given access to their own files and began adding self-assessments. These became the cornerstone of reform in teaching, learning and recording. The second half of the chapter deals with the inadequacy of current forms of assessment which neglect the pupil's capacity to self-evaluate. The author states "...the secondary school should docu-

ment pupils' progress and include both teachers' records and pupils' statements of self assessment....a file (should) be maintained for each pupil, maintained by teachers and open to pupils and their parents. It should contain 'objective tests' (1 or 2 per year); examples of pupils' work assessed by teachers; copies of public statements of assessments by teachers (e.g., to parents) and statements of self assessment by the pupils. The pupil should be free to view the file and add comments to it anytime and the final statement written at 16 should review their secondary school experiences and project what might follow". profiles.

Broadfoot, P. (1980). The Scottish Pupil Profile System. In T. Burgess & E. Adams, (Eds.), *Outcomes of education* (pp. 56-71). London: Macmillan Education Ltd.

Broadfoot describes a method devloped for the 16+ certification in Scotland for providing informative school records for potential employers and tertiary level educational institutions. The 'Pupil Profiles Project' was a research and development project of the Scottish Council for Research in Education. Its aim was to provide "a procedure which would be equally applicable to all pupils; which would gather teachers' knowledge of pupils' many different skills, characteristics and achievements across the whole range of the curriculum, both formal and informal....provide a basis for continuing in-school guidance, culminating in a relevant and useful school leaving report for all pupils. The case for using it is discussed in relation to the history of such reforms and current official proposals for reform from both sides of the Border regarding the 16+". profiles.

Broadfoot, P. (Ed.). (1986a). *Profiles and records of achievement. A review of issues and practice.* London: Holt, Rinehart & Winston.

This book,written by experts in the field, is a review of the issues and practices concerning profiles and records of achievement in British schools. The book is divided into 3 parts. Part 1: Personal perspectives includes the first three chapters of the book. Each chapter is written by a different person who has been intimately involved in the early development of pupil profiles. A fourth chapter is written by N. Baugart of Sydney Australia who presents an outsider's view of the profile movement. Part 2: Putting ideas into practice describes various 'records of achievement' systems which have been pilotted in school settings. Part 3 is a critique of 'records of achievement' which looks at the positive and negative aspects of the concept. .

Broadfoot, P. (1986b). Profiling and the affective curriculum. *Journal of Curriculum Studies*, *19*(1), 25-34.

This article provides an historical look at the development of the profile movement in England and Scotland. The relationship between the affective domain and profiles is discussed. The author states that little research has been done on the implications of profiles on the teaching/learning relationship or on the effectiveness of profiles as an assessment instrument or on the contradiction that may exist for some profile systems between the formative and summative functions of profiling. profiles.

Broadfoot, P. & Fenner, R. (1985). Pupil profiles: The promise and the peril. *The New Era*, *66*(2), 35-39.

The authors discuss the difficulty in designing profiles in order to meet all the desirable criteria of briefness and comprehensiveness. Possible abuses of profile information and inappropriate use of information are also discussed, for example: the lack of carefully evolved criteria and techniques in many profiling procedures that present a strong possibility for unfairness. The desire to give as extensive a

description as possible of a child's achievements, contributes to the flaws in the system. profiles .

Broadfoot, P., Nuttall, D., James. M., Stierer, B., & McKeeking, S. (1987). *Pilot records of achievement in schools evaluation* (Tech. Rep.). Bristol: University of Bristol, School of Education.

This is an interim across-site report of the 9 DES/Welsh Office-funded pilot schemes using records of achievement. The report is issues-focussed. It looks at both the research reports being produced by each scheme (often from more than one school) for the Records of Achievement National Steering Committee and the interim reports from the local evaluators of what they have seen in the classrooms and learned talking to teachers involved. profiles .

Brown, P. (1985). Pupil profiles: A new method of assessment. *Forum*, *27*(2), 51-53.

Peter Brown makes a critical assessment of the whole profiling movement. It is his opinion that: "Profiling is being presented as a universal panacea to replace what has been one of the most rigid and formal examination systems anywhere in the world. He argues that profiles are a more efficient way of reporting achievement and they should be used as a complement to an examination system, not as a substitute. If profiles are to replace examinations, validity, reliability and methods for administering them must be established. The inclusion of personal qualities in profiles will require radical changes both in the framework of education and the curricula of schools to allow for the monitoring of those comments by parents and pupils. profiles.

Burgess, T. & Adams, E. (1980). The present inadequacy. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 3-14). London: Macmillan Education Ltd.

The particular concern of this article is the lack of adequate records of achievement for those who leave school before doing the public examinations. Those who pass the examinations at least have a certificate, but they have no information that tells an employer or a tertiary level educational institute whether they will succeed or not. The public examinations are seen as inefficient, expensive and anachronistic. profiles.

Davies, E. (1980). Primary school records: St Anne's First School. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 119-131). London: Macmillan Education Ltd.

An account is given of the development in a first school (pupils 5 to 8 years of age) of internal pupil profiles. Beginning with the need to meet formal requirements, the school graduated to involving the children in their own progress, to full parental access to all school reports and towards joint decision making between teachers and parents. The pupils learned to reflect on their performance in language strategy tests, to comment on their abilities and their difficulties and to choose whether or not to know what was on their records. profiles.

Donoghue, R., Snow, R., & Spencer, K. (1986). Personal reviewing and recording. *Forum*, *28*(3), 75-76.

A discussion of a particular profile system, the OCEA (Oxford Certificate of Educational Attainment), its precursors, its composition, and how it is used. profiles.

Fairbairn, D. (1986). Profiling - Resourcing school-based development work. *Forum*, *28*(3), 73-74.

Seen historically, profiling is not a new phenomenon. What is different is

that the development of profiles has become a nationally coordinated exercise with widespread interest and support in Britain. While many teachers support profiling, they are concerned about the feasibility of putting the principles into practice and the additional workload this would entail. It is suggested that more extensive in-service and pre-service training will be required and that alterations to the structure of schools will be necessary in order to accommodate profiling. profiles.

Fletcher, C. (1980). The Sutton Centre Profile. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 46-55). London: Macmillan Education Ltd.

A report about a new community school where the head and staff built up a policy concerning assessments which involved students, parents, and teachers writing about and to each other. Continuous assessment throughout their school life is summarised in the student's Profile. The students contribute a record of their personal activities and compile a file of their best work. Public examination requirements are fulfilled by a Mode III of the C. S. E. Profiles have not always lived up to expectations. For example, profiles have been found to have little value in the local job market. (Employers when questioned replied that they did not read them.) and they are seen as mandatory and demanding. On the positive side, they have been found to play a part in the social development of the academically gifted. profiles.

Hargreaves, A., Baglin, E., Henderson, P., Leeson, P. & Tossell, T. (1988). *Personal and social education: Choices and challenges*. Oxford: Blackwell (Basil) Publisher.

Chapters 5 and 6 are of particular interest. Chapter 5 discusses personal recording, diaries and log books, their history of use in the classroom, the various forms they may take and the audiences for whom they are intended. In chapter 6 many reasons are given for the current popularity of records of achievement in the British educational system. While some reservations are expressed concerning invasions of privacy and their possible use as surveillance instruments to track the population, the overall view is a positive one. profiles .

Harvey, T. J., & McGovern, P. J. (1985). Teacher attitudes to pupil profiling: The use of an attitude scale. *Educational Studies*, *11*(3), 231-237.

This research report presents the initial outcomes from an attitudinal survey of 250 teachers in a number of British comprehensive schools. Attitudes toward seven areas were assessed: outcomes of assessment; purposes of assessment; the development, review and evaluation of assessment practices; teacher/pupil relations in assessment; assessment of the skills/affect domain; profiles; and related values. Percentages of teachers taking the different positions on each of the issues are presented. profiles.

Hicks, J. (1986). Pupil profiling and the primary school: A review of the issues. *Educational Review*, *38*(1), 21-30.

The National Profiling Network has been established to collate and provide information on the large number of projects dealing with pupil or student profiling systems, the literature that is accumulating on the subject and the output of profiles developed by individual schools and colleges. One of the difficulties encountered is the variation in what is called a profile. Salient characteristics of profiles are identified, and the development of the approach in secondary schools is briefly outlined. Some difficulties likely to be encountered in profile construction are identified, and the question of the validity of profiles is considered. Although there is as yet insufficient experience in this field to draw conclusions based upon observational evidence, the review tends to indicate that profiling has considerable

potential for use in the primary school but it has become something of an issue in secondary schools. profiles.

Hodson, D., & Brewster, J. (1985). Towards science profiles. *School Science Review*, *67*(239), 231-240.

In a good assessment scheme the procedures employed to assess the knowledge, skills and attitudes of children should be compatible with those used for planning and operating the curriculum. Profiling provides a comprehensive description of achievement in several areas: knowledge and understanding of concepts, principles, theories; levels of mastery of particular skills; attitudes; relationships with past performance and attainment of course objectives. The change in direction from stressing scientific facts to emphasis on the nature and structure of science teaching; the processes of scientific inquiry and fostering of positive attitudes to science and scientists parallels the move from the ingestion of facts for examinations whose results will be the sole measure of attainment to the preparation of profiles that give a more holistic view of attainment. profiles.

James, M. & Stierer, B. (1988). Records of achievement and a national curriculum. *Forum*, *30*(2), 41-43.

A statement of the findings of the Pilot Records of Achievement in Schools Evaluation (PRAISE) by two of the investigators. The authors ask a number of questions of the Task Group on Assessment and Testing in their paper. profiles.

Kirkman, S. (1988, March 4). A liberating influence. *Times Educational Supplement*, pp. 24.

The *Oxford Certificate of Educational Achievement* is described as a system of continuous assessment which involves pupils in their own learning and gives them the chance to record their achievements in and out of school. The final certificate lists skills in all areas of the curriculum and lists examination results; it also contains a "summary of achievement", written by pupils themselves, which includes out of school successes. The successes experienced by four local authorities using the OCEA is attributed in part to its flexibility. profiles.

Massey, A. & Newbould, C. (1986). Qualitative records of achievement for school leavers: An alternative approach to the technical issues. *Cambridge Journal of Education*, *16*(2), 93-99.

The Record of Achievement used in Wales (RoA) includes only positive statements from teachers and administrators plus input from the pupils themselves. It explicitly rejects the practice of grading personal qualities. It encourages the use of comment banks and negotiated statements. The policy of the DES supports the co-existence within the RoA of examination results and systematic assessments in basic subjects, thus providing a history of achievement for those who do not pass the exams (school leavers). Massey and Newbould say, "We should see the Record rather more as a device for reporting, for describing pupils, than as an assessment instrument." profiles .

McGovern, P. (1986). The INSET needs of a school developing a profiling system: Part two - Developing the profilers: Making INSET work. *The New Era*, *67*(3), 77-79.

INSET stands for inservice education and training. Part one deals with inservice education and training as a whole while part two deals specifically with the needs of teachers embarking on a system of profiling as an assessment instrument. Profiling demands new attitudes and more effective skills from teachers than most other forms of assessment. In order to meet those radical changes the individual learning milieu of a school has to be changed. To accomplish this a six-

teen week programme of one day per week was organised for coordinators and small groups of teachers were involved in later sessions. The teachers who will be involved in actually doing the profiling were encouraged to voice opinions and make suggestions. profiles.

McLean, L. (1985). *The craft of student evaluation in Canada*. Toronto, ON: Canadian Education Association.

Includes a look at different methods of assessment. A number of recommendations are made. Pages 44-45 deal with profiles/writing folders/dossiers used in Britain and France as instruments for keeping track of achievment. profiles.

Mitchell, A., Perfect, H. & Boyd, J. (1985). Scope for profiling: Computer support for teachers in developing profiled reports. *Programmed Learning and Educational Technology*, *22*(4), 307-314.

This paper describes an attempt by science teachers in a secondary school to delineate a meaning of 'profile' in the context of an integrated science course, to organize their assessment accordingly and to produce profiled reports with the support of a computer. In this instance the term profile is used to mean a report of pupils' achievements based on a criterion-referenced type of assessment of essential elements of the course. Elements are defined as abilities which pupils are expected to gain and develop as a result of going through the course. Two computer packages - SCRIBE and SCOPE - were designed as a resource in school-based assessment for teachers. SCRIBE concentrates on reporting scores on single tests, SCOPE accumulates data from a series of assessments and reports the accumulated information as records of achievement in various elements which are defined by the teacher.

Mortimore, J. & Mortimore, P. (1984). *Bedford Way Papers*: Vol. 18. *Secondary school examinations*. London: Institute of Education, University of London.

This paper documents a number of issues concerned with secondary school exams in England and Wales. It begins by describing the evolution of the present system over the last 150 years, and traces the growing unease over the constraining effects of examinations. The pressures for reform and the various proposals for changes in examinations are discussed and evidence of the resistance to change, particularly from the universities, is presented. Profiles are discussed. "The challenge for the developers of profiles and graded assessments is to devise assessments which not only motivate pupils, rather than turn them off, but which are also sensitive and efficient.... and which have a common structure for all subjects, and yet within the structure allow freedom to be flexible." profiles.

The National Curriculum 5-16. (1987, December 31). *Education*, pp. 35-38.

An Education digest summarising the DES document. The outlines of the proposed national curriculum for all maintained and voluntary schools in England and Wales were published in a consultation document, issued by the Department of Education and Science and the Welsh office on 24 July. The shape of the curriculum and the machinery for delivering it to schools, which will be the subject of the major legislation, are summarised in this article. profiles .

Neave, G. (1980). Developments in Europe. In Burgess, T. & Adams, E. (Eds.), *Outcomes of education* (pp. 72-89). London: Macmillan Education Ltd.

The differences between Britain and Europe in educational administration, teaching and asessment are compared. In Europe, national education systems mean a national curriculum and nationally ascribed objectives. In Britain, the local education authorities are ostensibly free to prescribe their own curricula. But

the necessity for certification at 16+ using a public examination limits that freedom considerably. The English ideology of the curriculum allied to a highly diverse structure of examination boards poses a particular obstacle to the development of pupil profiles. Although France retains a public examination for 16+, there is also a backup of school record cards which provides information on all pupils including those without certificates. In Norway and Sweden, record cards are replacing the national examination system. Britain and Denmark rely predominently on examination results. France is in a state of transition where examinations are still the major instruments for educational assessment with an alternative source of information in the pupil's individual record, calibrated to national norms. In Norway and Sweden, the major instrument stating the attainment of 16-18 year olds is the pupil profile system, nationally standardised, in which the 16+ examination has given place to a regular series of standardised tests routinely administered to all children at certain points in their school careers. Each of these countries intends to use profiles more extensively in the future. profiles.

Needham, R. (1986). Profiling in pre-vocational programmes. *Forum*, *28*(3), 77-78.

Pre-vocational courses are courses where people are trained to work in a trade. Most pre-vocational courses involve some profiling. The aim is to tell whomsoever it may concern what the person can do. According to the author, it is in formulating this information that the greatest advantages of profiling occur. The interaction between student and tutor can become a counselling session with positive guidance being offered by the tutor and a meaningful dialogue occuring. Unfortunately, "profiling is a time consuming often misunderstood process, with the results all too often ignored by those whom it was originally intended to help - the employers." profiles.

Raven, J. (1980). Bringing education back into schools. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 104-118). London: Macmillan Education ltd.

Research shows that schooling is mainly devoted to teaching and learning examinable bodies of knowledge - although both teachers and students think the aim should be to develop our most human capacities. Examinations are commonly held to be justified on the grounds of measuring general ability and predicting human potential. These claims are ill-founded. Lacking in the common formula for schooling is self-motivation, the hidden key to developing multiple human qualities such as resourcefulness, initiative and ability to learn from experience. It is proposed to switch the focus in schools from content to competence. Three techniques, student self-assessment, projective techniques, and teacher ratings are suggested as ways to give teachers and students credit for working towards such process goals. profiles.

Richmond, J. (Ed.). (1983). *English in schools. What teachers really try to do.* London: Institute of Education.

A group of English teachers describe their experiences with teaching English in inner city schools under the handicap of underfunding, understaffing and a population of diverse backgrounds and needs. The teachers advocate the accumulation of a comprehensive record of student attainment, often referred to as 'a writing folder', which would contain a meaningful, concrete, directly interpretable record of a student's achievement with comments by teachers, parents and the students. profiles.

Simons, M. & Erling, S. (1986). *Writing folders field study 1985-1986* (Tech. Rep.). North York, ON: North York Board of Education.

This is the report of a field study which took place in North York during the 1985-1986 school year. The purpose of the study was to determine the use of writing folders in the classroom at the primary, intermediate and senior levels and whether that use motivated students to improve their writing skills, write more frequently and more creatively; improved the ability of teachers to assess and modify their programs to meet the needs of students; helped students organize their work and clarify the steps in the writing process; encouraged students to accept responsibility for their own work; increased student willingness to share their work; and supplied satisfactory pieces of work for both formative and summative evaluation. profiles.

Stansbury, D. (1980). The record of personal experience. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 39-45). London: Macmillan Education Ltd.

A teacher who has been reponsible for the design and dissemination of two systems of personally compiled records explains how these systems operate. The *Record of Personal Achievement* and the *Record of Personal Experience, Qualities and Qualification* are built up by students in the 14-16 age group for use as a qualification. A case is made for making it possible for all students to compile records of this kind. profiles.

Stephenson, J. (1980). Higher education: School for independent study. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 132-149). London: Macmillan Education Ltd.

The Diploma of Higher Education in one polytechnic is based entirely on each student's self-assessment, stated aims, present and future plans, and promised outcomes. The reasons for abandoning syllabuses and examinations at the school are discussed, illustrated and summarised. profiles.

Stevenson, M. (1983). Pupil profile - An alternative to conventional examinations. *British Journal of Educational Studies, 31*(2), 102-116.

Almost all of "our present asessment procedures have been directed towards cognitive outcomes....The proposals for developing pupil profiles stem largely from a concern that public examinations do not adequately measure or express pupil's developments or attainments." It is the contention of this paper that criticisms of one form of assessment "may not be regarded in themselves as justifications for another form of assessment." There is a need to analyse and critically appraise the claims which are made for such profiles before conclusions can be reached about their use as an alternative form of assessment. profiles.

Task Group on Assessment and Testing. (1987). *National Curriculum: Task Group on Assessment and Testing: A Report.* London: Department of Education and Science and the Welsh Office.

A report prepared for the Secretary of State by the Task Group on Assessment and Testing to advise on assessment and testing within the national curriculum. profiles.

Task Group on Assessment and Testing. (1987). *National Curriculum: Task Group on Assessment and Testing: A digest for schools.* London: Department of Science and Education and the Welsh Office.

A digest prepared for the information of school teachers summarising the report of the Task Group on Assessment and Testing. profiles.

Townsend, C. (1980). School and work. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 150-159). London: Macmillan Education Ltd.

Nationally, the Manpower Services Commission has found that few young people seeking employment have been guided or assessed in ways that enable them to get and hold down a job or in ways that help the employer to select suitable applicants. Action research is in progress to develp an inventory of the broad based skills found to be needed in the jobs in local areas. It is argued that the school examination system tends to create two classes, the employed and the unemployable. The knowledge and use of the inventory should bridge many gaps dividing the education system, the labour market services, employers and unions.profiles.

Whitehead, J. & Whitehead, J. (1980). Evaluation and learning in secondary schools. In T. Burgess & E. Adams (Eds.), *Outcomes of education* (pp. 30-38). London: Macmillan Education Ltd.

Illustrated accounts are given of how two schools, building on experience of the Schools Council's *Mixed Ability in Science Project*, are integrating learning with evaluation for students aged 11 to 14. In each case an extension to the 14 to 16 age group is proposed with a view to recommending a form of student profile worthy of national validation. The statements in the student profiles will be based on the moderation procedures used in 100 per cent Mode III coursework assessment in the Certificate of Secondary Education. profiles.

Structuralism/Functionalism Bibliography

an annotated bibliography by M.E. Rosser

Badcock, C. R. (1975). *Levi-Strauss: Structuralism and sociological theory.* London, Eng.: Hutchinson & Co.
strucfunc.

Eisner, E. W. (1987). Structure and magic in discipline-based art education. In *Discipline-based art education: What forms will it take?* (pp. 6-21). Los Angeles, CA: Getty Centre for Education in the Arts.
"Structure in a curriculum...permits sequence to occur...sequence...:the organization of activities so that they challenge, develop and build upon the ideas and skills that students have previously acquired." curdev strucfunc.

Fischler, A.S. (1968). Implications of structure for elementary science. *Science Education, 52,* 277-284.
Makes a rhetorical attempt to tie psychological to logical in a curriculum. The paper roams over topics such as curriculum development, scientific enquiry, student enquiry, and the like. scied strucfunc.

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Ringle, W. (1981). Saussure and the formulation of continental structuralism. *Human Mosaic, 15*(2), 33-56.
A study of Roland Barthes and of the semiotic perspective in general with focus on the problem of meaning, explanation and interpretation within the works of several recent continental scholars. Their philosophical tenets are rooted in the structural approach to language espoused by Ferdinand de Saussure in 'Cours de Linguistique Generale'. Structuralists such as Levi-Strauss and Roland Barthes expanded Saussures's systemic/structural linguistic constructs to other areas of human symbolic activity e.g. myth, ritual and literature. According to Paul Ricoeur, however, structuralism ignores the role of reference within linguistic meaning, resulting in the portrayal of language as a static system. strucfunc.

Schwab, J. J. (1971). Structures and dynamics of knowledge. In Levitt, M. (Ed.), *Curriculum* (pp. 181-214). Chicago, IL: University of Chicago Press.
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Theodorson, G. A. & Theodorson, A. G. (1969). *A modern dictionary of sociology.* N.Y. NY: Thomas A Crowell Co.
strucfunc.

From Comte to Structural Functionalism

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Comte attempted to provide a new consciousness of social reality, an attempt by him to reduce phenomena to 'aspects of a single fact'. The knowledge thus obtained would not be just theoretical but would have practical uses as well. It would provide a 'positive' philosophy for looking at social organizations (positive is used here synonymously with scientific). He saw mathematics as historically the first of the positive sciences followed by astronomy, physics, chemistry and biology. For Comte, Sociology was supreme in the hierarchy of Sciences. Each science depended on the one below it, thus physics depended on mathematics. But while depending on the base of mathematics, physics was independent in that it could not be reduced entirely to mathematics. While this explanation worked for physics there was difficulty using it for Sociology. If Sociology was seen as paramount in the hierarchy, it could not be the base for anything else. In Comte's hierarchy, each field of knowledge was both itself more complex than what went before it and competent to study a reality more complicated than those below it. Thus, as Sociology was the apex of the hierarchy, it was able to study the most complex reality know to Man, Society itself.

He formulated the Law of the Three Stages: Each branch of our knowledge passes through three different theoretical states: the theoretical or fictive state; the metaphysical or abstract state; and the scientific or positive state. It was this last state that was elaborated in his *Politique Positive* (1851-1854). Although in his writing, he promised to provide empirical evidence for the great law he had discovered, he never did. Durkheim tried to provide the empirical basis that Comte did not provide. For him, Positivism became identified with the methods of the empirical sciences. He, Like Comte and the philosophers before him, was looking for a way of explaining the development of primitive societies which would be compatible with the means of explaining the development of Western Societies. Comte had become tied up in theory and religion, Durkheim was going to deal with 'social facts'.

Yet, by following this dictum, he ended by separating the collective from the individual and failed to emphasize the possibility of understanding social phenomenon from the inside, i.e. from the minds of the individual participants. As Levi-Strauss wrote, "This corresponded to a general fault of science whereby the subjective properties are left to one side while we seek explanation in purely

objective terms". Positive Sociology, for Durkheim, became the study of norms; statistical on one side, structural on the other. As he saw norms as the basis of social order and sociology could only explain by reference to these norms, then all explanations must be in terms of the whole society rather than in terms of individual action. Durkheim's theory was that all ideas and categories of thought have a social origin. They originate in the collective consciousness. Durkheim was not able to use his theory to explain emotion. For him, it was inexplicable. He failed to provide a genuine reductive explanation of social phenomena, i.e. the causal connection between the collective conscience and the individual.

Another sociologist who influenced Levi-Strauss was Marcel Mauss who co-authored *Primitive Classification* with Durkheim. Mauss was able to resolve some of the limitations of Durkheim's system and provide Levi-Strauss with the principle means for overcoming the limitations of Durkheim's system. Mauss isolated the principle of reciprocity which had important implications for the Structuralists' approach to Sociology. He gave explanations which eventually led Sociology not only to describe particular institutions in functional form but to explain why the particular form of the institution existed. Mauss brought together the thinking of Comte and Durkheim. He approached the analysis of phenomenon in terms of their form and on the basis of objectivity. Like Durkheim, Mauss drew moral conclusions from his work. He talked of structural solutions, of solutions to modern problems of want and injustice which are independent of attitudes, e.g. workers' insurance which will redistribute wealth in such a way that those processes of inner communication which underlie all social wholes will function on the basis of a new more thorough going principle of reciprocity. For Mauss, the principle of reciprocity guaranteed equality for structural reasons.

Levi-Strauss is the best know exponent of the Structuralism position. He holds that cultural forms especially myths, typically take the form of the combination of opposite qualities called binary oppositions. Analysis of myths takes the form of showing what binary oppositions are manifested. Explanation for the form the myth takes is found in unvarying qualities (structures) of the human mind (Levi-Strauss 1976). He gives for example the story of a king and a shepherdess. These two words are taken out of the story and used to construct an intelligible system formed by opposites: male/female (Nature); high/low (Culture); and all possible permutations of the six terms in order to explain the culture of the people telling the story. He sees Social Anthropology as a taxonomy whose purpose is to identify and classify types, to analyse their constituent parts and establish correlations between them.

By contrast, Radcliffe-Brown wanted to make Social Anthropology an inductive science in keeping with the views of Durkheim. It would involve the construction of hypotheses which would be submitted to experimental control in order to discover the general laws of nature and society. He did not see himself as a functionalist: "The statement that I am a 'functionalist' would seem to me to convey no definite meaning" (This comment grew out of Malinowski's description of Radcliffe-Brown as a functionalist). Radcliffe_Brown saw each scientist as starting from the work of his predecessor, finding problems and by observations and reasoning making a contribution to a growing body of theory. For him, Social Anthropology was the investigation of social phenomenon by methods similar to those used in physical and biological sciences.

If we move from European to American Sociologists, we encounter Talcott Parsons and his Structural-Functional Analysis (also based on Durkheim). Structural-Functional Analysis is a methodological and theoretical framework for the analysis of social phenomenon in terms of both the structure of the society and the functional relation of its parts. This approach is similar to the perspective of the biologist, who views the operation of the body in terms of both its structural parts and the functions they perform in the total system. Structural-Functional Analysis presumes that social units (groups, institutions, etc.) that are in interaction mutually influence and adjust to each other so that through the various social processes, including cooperation, competition, conflict and accommodation, the various groups and segments of the society form a relatively unified social system. Structural-Functionalism is essentially synonymous with Functionalism. However, the term Structural-Functionalism usually implies a greater emphasis on the formalistic analysis of the structural aspects of society and social systems (Theodorson & Theodorson 1969 p.422). Social structure is the pattern of interrelated statuses and roles found in a society or other group at a particular time and constituting a relatively stable set of social relations. It is the organized pattern of the interrelated rights and obligations of persons and groups in a system of interactions and social institutions (p.395).

Talcott Parsons in his *The Social System* 1951, describes what is involved in a Structural-Functional Analysis and what one is able to do with one. (It moves to the elaboration of more categories than the reductionist theory of Levi-Strauss).

> The set of descriptive categories ... is a carefully and critically worked out system of concepts which are capable of application to all relevant parts or aspects of a concrete system in a

> coherent way. This makes comparability and transition from one part and/or state of the system to another and from system to system possible. It is of the greatest importance that this set of descriptive categories should be such that the dynamic generalizations which will explain processes are directly a part of the theoretical system .... The system of structural categories is the conceptual scheme which gives the setting for the dynamic analysis ... primary concern must be with the categorization of the structure of the social system, the modes of structural differentiation within such systems and the ranges of variability with reference to each structural category between systems. (pp.20-22)

It is by placing this dynamic process structurally in the social system that Talcott Parsons and his co-workers are able to look at fundamental relationships between need-dispositions of the personality, role expectations of the social system and internalized-institutionalized value patterns of a culture. It is what he calls a "Theory of Action" (p. 540)

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Curriculum Sequencing and Ordering: An Historical Overview

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Massive changes occurred in Mathematics education between 1890 and the present. Many of those changes both in North America and Europe were a result of the impact of the needs of a rapidly developing society. The move from an agrarian to industrial to post industrial and service economy required modification in the areas of mathematics to be taught and the methods for teaching that mathematics. The philosophy of mathematics teaching changed as the society changed.

In pioneer North America, a teacher might be a failed entrepreneur,a retired soldier, a young son of a noble family. Teaching was a profession with little status. But as the population grew and the needs of the society changed , it was recognized that 'trained' people were needed. Mental discipline needed development and mathematics was seen as an avenue to attaining that discipline.

For example, The Committee of Ten (NEA 1898) submitted the following conclusions (only those relating to Grades 7 and 8 are included)

1. To the close of secondary school the required work should be the same for all pupils.
2. The formal instruction in arithmetic should terminate by the end of Grade 7.
3. Half of the time allotted to mathematics in seventh grade should be given to beginning of demonstrative geometry.
4. If geometry has to be put off until later it should still be taught prior to algebra.
5. Equal time in Grade 8 for algebra and demonstrative geometry. The unity of the work in mathematics is emphasized and the correlation and interapplication of its different parts recommended.
6. The instruction should have as its chief aim the cultivation of independent and correct thinking on the part of the pupil.
7. The importance of thorough preparation for teachers, both in mathematical attainments and in the art of teaching is emphasized. (Osborne & Crosswhite, 1970, p. 169-170)

Industrialization pressured educators to prepare the young for vocational life. Students were to be shaped to fit the business mold. At the same time psychology was becoming an important fact of life and Thorndike's concern with measurement dictated the direction of mathematics teaching during the first two decades. Attention was concentrated on what could be measured and the results of those tests. Utility was stressed. "Our knowledge of mathematics enables us to answer questions that arise about the entire quantitative side of life"(Osborne & Crosswhite, 1970, p. 192)

The National Council of Teachers of Mathematics was founded in 1920. It was a response to educational reformers who had made a mess of mathematics teaching. Their aim was to have teachers of mathematics directly involved in the development of mathematics curricula and have them aware of what was happening throughout the States. The 1923 Report rejected the concept of mental discipline as a psychological base for curriculum organization and substituted 'transfer'(the theoretical construct of transfer was not defined). The 'function' concept became "the one great idea which is best adapted to unify the course(function here refers to incidence of functions in mathematics and science and the potential for usage by students" (Osborne & Crosswhite, 1970, p. 202).

Unification of the curriculum was stressed and the utilitarian concept was integrated. The demand for practical problems was to be met as far as the experience and maturity of the pupils would allow.

The Progressive Education Association was formed in 1919, although much of its views were implicit in the mathematics education since 1900. The unified mathematics movement, the real/applied problem movement and the scientism of the early testing movement were all parts of its philosophy. Dewey's work played a part in the Progressive movement but he went beyond it and developed the view that education must be built on a foundation of the intrinsic activities and needs of the child (Osborne & Crosswhite, 1970, p. 215). He introduced the human factor into Thorndike's stimulus-response mechanism, caught the attention of educators and his work emerged to dominate the educational scene for many years. Psychology took over to shape the thinking of mathematics educators (education in general as well). As different psychological views took prominence, they in turn altered the view of educators, from Thorndikes's stimulus-response mechanism, to Gestalt, to field theories and the emergence of cognition as an important force in the 1940s.

The school population was expanding and exerting pressure on the educational system. There was room for many and varied philosophies to exist. The Progressive Education Movement continued to grow along with the psychological and measurement movements. Mathematics left the field of education and returned to the theoretical aspect of the discipline.

The various forces at work in education had more effect on junior high school texts than on senior. The aims, content and methodology provide evidence of the shifting perception of what was important (Osborne & Crosswhite, 1970, p. 218). Although much was made of teaching for meaning,

the primary instructional method of the twenties was drill. The texts of the 1920s incorporated little of the recommendations of the 1923 Report. Nontraditional materials were placed at the end of texts where they could be 'missed' if the teacher ran out of time. "The texts of the 1930s demonstrated a profound shift in emphasis. The content of junior school texts incorporated more mathematics for purposes of socialization" (Osborne & Crosswhite, 1970, p. 219). Lengthy drill and review exercises were omitted. Tests were included. Algebra was taught on a more elementary level. Emphasis was on the use of mathematics in a democratic country.

Two major curriculum reports for secondary school mathematics were published in 1940: *Mathematics in General Education* by the Progressive Education Committee. *The Place of Mathematics in Secondary Education* by the Joint Commission of the MAA and the NCTM. There were some basic differences in the two reports. The goal of the PEA was to study the teaching of mathematics for its values in relation to the whole process of general education. Broad categories of mathematical behaviour were chosen as applicable to the problem solving of life. The Joint Commission was concerned with specific subject matter recommendations. It recognized that there was no perfect curriculum program with sufficient merit and flexibility to meet a wide variety of needs. It also recognized that mathematics needed to be unified to get the optimal cultural return. Both reports argued for the importance of mathematics in the school curriculum at a time when mathematics was receiving a lot of negative press. Both reports produced positive, forward looking statements at a time when the society was experiencing the negative impact of the Great Depression.

With the advent of World War II, importance shifted from the social well being of students to the preservation of the American way of life. Mathematical content with military uses was recommended as the most socialized variety for boys. Remedial courses of an emergency nature were implemented because may young men were judged incompetent in mathematics during the testing for their induction into the armed forces; as well, expertise was needed for the increasingly technical industries.

The years 1947-1967 mark a further revolution in the teaching of mathematics and the emergence of a multitude of reports addressing the problems in mathematics. The Harvard Report (1945) specified that by the end of the 7th or the middle of the 8th Grade, every pupil should have acquired a reasonable facility in the language of arithmetic, some appreciation of the number system

and the power of mathematics in formulating and solving problems in the real world and the commoner facts of geometry either by induction or intuitive reasoning (Osborne & Crosswhite, 1970, p.242). Mathematics was seen as an abstract logical structure that prepared you for further education. Unfortunately it was of little use to those who could not go on. The Commission on Postwar Plans formulated a unified mathematics program for Grades 7 and 8. It published a number of reports from a very general one to one with a checklist of 29 specific areas to be covered to a final report which presented mathematics as a tool that was functional and met the needs of different strata of the society.

Concern about the quality of mathematics education continued. Kenneth O. May wrote in the May 1954 issue of *Mathematics Teacher* "the present crisis in mathematics is due not to any deterioration in the work of mathematics teachers, but to an urgent national need for more and better mathematics at a time when administrators and the public have for years slighted mathematics and discouraged all vigorous mental effort in the high schools....Excellence in scholarship is permitted, but mediocrity is considered more "democratic".(p.303)

The UICSM (University of Illinois Committee on School Mathematics) since 1951 has been viewed as "progenitor of all current curriculum projects in mathematics" (Osborne & Crosswhite, 1970, p.251). The Committee received extensive government funding. At the beginning of their work they decided that all the material they proposed for use would have to be classroom tested instructional material. All their materials were made available in classroom lots to teachers who had 'special training' in their use and to none other. The training was given in special summer sessions. Additionally the UICSM established a pattern of curriculum revision which addressed itself not only to significant changes in classroom content but also to the development of a teaching philosophy consistent with the new mathematical emphasis.

The SMSG (School Math Study Group) was organized by mathematicians. It grew out of 2 conferences of university mathematicians. Their concern was the dearth of research mathematicians. They took the view that the shortage was due to the inadequate early training in mathematics. Two specific recommendations came from the conferences that writing sessions be held to prepare a detailed syllabus for a model secondary program and that a series of monographs on mathematics topics of interest be prepared. The AMS officially expressed interest in the mathematics curriculum.

This was the first time that the AMS had involved itself in mathematics at the elementary and secondary school levels. "The approval of the Society made it possible for a large number of distinguished college teachers and research mathematicians....to cooperate with high school teachers....to improve the quality and presentation of school math"(Wooton, 1965, p.12-13). A writing group of 45 people was formed: 21 college teachers of mathematics, 21 high school teachers and one representative each from Rand Corporation, Bell Telephone Laboratories and the American Association for the Advancement of Science. The general objective of the SMSG was "That mathematics be so taught that students will be able in later life to learn the new mathematical skills which the future will surely demand of them" (Wooton, 1965, p.49). They had three specific objectives:an improved curriculum which would preserve skills and add a deeper understanding of mathematics; the preparation of materials for teachers to enable them to teach the improved curriculum; and the presentation of mathematics in a more favorable light in order to attract students. One of their tasks was to design a detailed outline for a series of mathematics textbooks Grades 7-12. These textbooks were to serve as a model for the commercial textbook developers. "It was (and is) an acknowledged fact that the most important single factor in determining curricula content in the schools is the textbook"(Wooton, 1965, p.20).

A subgroup was formed which had the responsibility of designing a series of experimental units on single topics for Grades 7 and 8. For a long time the teaching in Grades 7 and 8 had consisted of a poorly organized presentation of much review of Grades 5 and 6. Little was known of what could be done at this level because little had been tried. They began by examining the material of the UMMaP (University of Maryland Mathematics Project) one of the few serious attempts to create a new junior high school mathematics curriculum. The SMSG subgroup took the philosophical viewpoint that the junior high school curriculum would be essentially exploratory in nature.

"To write the units, the subgroup divided itself into teams of two: one high school teacher and one mathematician. Choosing an area in which both members of the team were particularly interested....they first outlined the unit in detail with the mathematician determining what aspects of the topic were of mathematical significance while the classroom teacher...gave special consideration to ways and means of presenting the material in the clearest fashion" (Wooton, 1965, p. 23) As well, they worked together on the material. When the pair were satisfied with what they had done, the material was duplicated and given to each member of the Grade 7/8 subgroup for criticism. A general meeting

of the subgroup was held and each section of the work was considered paragraph by paragraph. The initial team would then re-write the material or if they felt they could not better what they had done, another team was assigned to try. Another meeting would be held to discuss the revised text and so it would continue until all members of the subgroup agreed that the material was ready. They would then go on to another topic. In total thirteen topics were handled in this way. The materials were field tested in 1958-1959.

They knew teachers tended to teach as they had been taught, mostly by lecture and drill. They, instead, stressed the discovery approach, the spiral curriculum, the importance of structure and the role of intuition. The basic aim in these new emphases was that the pupil should play an active role in the development of mathematics, too. (Osborne & Crosswhite, 1970, p. 279). The SMSG continued its work for more than a decade. The group was always conscious that without the cooperation of the teacher none of these curricula could achieve anything.

"It is almost thirty years since the 'Modern Mathematics' reforms began.... few would wish to seek the like of the 1960s again....much was attempted in too short a time with insufficient thought concerning aims and possible effects....no comprehensive, international analysis of the reforms has been written to date". The authors go on to give a very brief survey of the theories propounded during that period. "Once it was recognized that each of these concerns was valid, attempts were made to find a comprehensive theoretical structure. Establishing this proved an extremely difficult task, the only theory to achieve this integration (on a rather high level) being that of Bruner. Yet this was a sophisticated approach that proved difficult to translate....the structuralists set new standards concerning the balance and integration of the constituent aspects of curriculum development on a scientific level"(Howson, Keitel & Kirkpatrick, 1981, pp. 238-239). Much of this was lost to the pressures of politics. The concern that in spite of all the new proposals and programs mathematics did not meet the needs of 'Everyman' and all aspects of societal needs left it open to political manipulation. Politics interfered as lobbying went on for this group or that group for which the then current mathematics program was inadequate. Much was thrown out and altered with little concern or interest in the overall effect. With the emergence of the structuralist and formative approaches to curriculum development,the learning process itself, and the teacher with it regained their central place in curriculum thought.(Howson et al., 1981, p 242).

The educational reform movement of the 1960s in the U.S. spilled over into Canada. Textbooks used were published in the U.S. or Canadian equivalents were published for use in the schools. Each province like each state made independent decisions about what would or would not be part of the curricula. In Quebec these was the problem of three parallel educational streams: the French Catholic, the English Catholic, and the English protestant school systems. The religious orders controlled what was taught in the Catholic schools and the mathematics curriculum (when stressed at all) followed the European trend towards 'pure' mathematics. In Ontario from the 1950s, teachers were encouraged to take an active part in curriculum planning. The main impetus came from the U.S. with the same philosophical views being stressed. From 1920 -1945, the emphasis was on revising the curriculum to meet the requirements of life more adequately, from 1945-1959, the trend was towards programs for the majority. Of the Ontario system in 1920 (prior to the U.S. influence), it was seen as "at once one of the most uniformly efficient in the world and one of the most paralysing of individual initiative in teacher or school" (Crawford, 1970, p. 392).

Increase in population was one of the most decisive factors in change of philosophy. As the schools filled with more of a cross-section of the populace, more pressure was exerted to meet the needs of all segments. The 6-3-3 Grade dispersal of the U.S. was adopted in British Columbia, Alberta and Nova Scotia. The guarantee of funding to Grade 10 for Catholic schools in Ontario prevented implementation of the 6-3-3 breakdown.

Meeting the needs of the majority often meant reduction in standards. In 1950, J.A. Sonley, president of the OEA Mathematics and Physics Section said "the mathematics course in elementary school has been 'watered down' until the Grades 7 and 8 mathematics texts resemble a book in Social Studies with a few fractions thrown in to separate topics" (Crawford, 1970, p. 403). He cautioned against letting the pendulum swing to the other side or adopting experimental ideas that had not been adequately tested.

An important change in the 1950s was the discontinuing of provincial policy of prescribing one textbook per subject. Local groups were allowed to make their own decisions about what textbooks to use (from a recommended list) and allowed to revise the curriculum. The late 1950s and early 1960s saw a general trend towards reorganizing post elementary education to provide more adequately for individual differences and a concern to raise the standards of teacher education.

The decade 1960-1970 saw greater flexibility in curriculum development, use of texts, methodology and school organization. The Canadian Mathematics Congress stressed summer courses for upgrading mathematics teachers. The need to involve teachers in curriculum planning was recommended. Particular concern was expressed about the junior high school level. "It would appear that the level requiring the most study and experiment now is the junior high school level, say ages 12 to 16, for this is the transitional period during which students test their abilities and interests and so need help in making decisions that will affect their future significantly" (Crawford, 1970, p. 446).

In the Ontario curriculum guideline Mathematics Intermediate and Senior Division of 1985, the aims for Grades 7 and 8 stress development in attitude toward an appreciation of mathematics, facility in the language of mathematics, consolidation of the skills learned in the lower grades and participation in those experiences that will lay a foundation for the development of the more abstract features of mathematics in later grades.

The British Columbia Curriculum Guide for 1987 Mathematics Grades 1-8 specifies as its goals the development of skills in logical analysis and problem solving, the provision of the mathematics necessary to function in society and engage in 'life-long' learning and the knowledge necessary to pursue further formal study in mathematically related areas.

The historical evolution of mathematical curricula in the U.S. and Canada as discussed above has dealt with the changing times and the changing philosophies that went with those times. The concentration has been on Grades 7 and 8 or junior high school. Theories which dealt primarily with the earlier grades have not been discussed. Some attention has been given to senior high school when the two (junior and senior) were being viewed together as the secondary school.

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Summary of Task Group on Assessment and Testing Report

A number of committees have been set up to prepare materials for presentation to the British Parliament on the subject of the National Curriculum which will set Britain aside from other countries in that Britain will be the only one with a nationwide curriculum.

The Task Group on Assessment and Testing was given the task of advising the Secretary of State on testing and assessment within the national curriculum. Under the chairmanship of Professor P.J. Black, they have presented four general criteria. Pupils' achievement should be criterion-referenced,formative, moderated and should relate to progression. To attain the formative purpose of the NAS, pupils' results in a subject should be presented as an attainment profile. Subjects should be broken into small numbers of components reflecting the variety of knowledge, skills and understanding embodied in the subject. Each component should be a cluster of attainment targets which have some homogenity in relation to the skills and understanding of the subject. For example, in Science, the 3 components: skills, knowledge and understanding and exploration form the profile on which a pupil's achievement will be measured. Whenever possible one or more components should have more general application across the curriculum. For these, a single common specification should be adopted in each of the subjects concerned. A mixture of standardised assessment instruments: tests, practical tasks and observations by the teacher of a pupil's performance over a period of time will provide the records of achievement. For 16 year olds who are at the end of the statuary period of education, a summative statement providing a comprehensive picture of the pupil's achievements will be available.

The Task Group recognizes that assessments of individual children must continue to be the responsibility of the teachers and teachers assessments should be a fundamental part of the system and teachers should be given more support as assessors. The assessments being proposed by the TGAT are similar to a teacher's day-by-day assessments: they are directly concerned with what is being taught and are designed to

reveal each pupil's performance irrespective of the performance of other pupils.

In order to facilitate the reports of assessment it is proposed that 10 levels be established to cover the full range of progress of a child from age 5 to 16. There will be 4 reporting stages: 7, 11, 14, and 16. The reports will consist of the teachers' assessments and the results from externally provided tests. For 7 to 11 year olds, it is proposed that the tests take the form of tasks/topics for the children to work on which will resemble their usual day-to-day classroom work. A bank of testing materials will be available from which the teacher may choose what is appropriate to the particular class with enough choice that not all children will work the same task at the same time. For 14-16 year olds, subject-related tests will predominate. The 16 year olds will not be assesed on the NC for subjects they are preparing for the GCSE.

The teachers' information on pupils will be from 2 sources. Their own observations of the pupils daily work plus marks arising from the tasks or tests. The teachers will bring samples of their pupils' work to a moderation meeting where they will discuss how marks were assigned. The group will have to come to consensus on the criteria for scoring and results. The group will also determine the overall mark distribution for a class at the level being discussed. Any flaws (unresolved disagreements) are to be reported back to a regional agency which in turn will report to the School Examination and Assessment Council which will consider the action to be taken, e.g. a revision of the task or a decision that the task is alright but the moderation group was reporting a local aberration. The aim of the 'moderation' is to make the system interactive with input from the teachers as well as a central body.

Very little information appears in this document regarding Records of Achievement. The report of the Records of Achievement National Steering Committee is included as one of the appendices. They are described in the Task Group document as a proposed method for recording and reporting pupils' progress, achievement and their personal and social development. They are seen as resulting from continuous interactions between the

teachers and the children. At each reporting age (7,11,14,16), the parents will be told what levels their children have reached in the various profile components and how their peers rank both within the school and nationally.

During a pupil's school life, progression on nine to eleven foundation subjects will be assessed. Each subject is comprised of skills, ideas and activities which need to be achieved and/or assessed. In order to deal with some precision and yet make reporting comprehensible, it is recommended that 4 - 6 clusters of components or profile components be identified for each subject area with some of the profile components overlapping a number of subjects so cross-curricular themes can be emphasized. Pupil results can be reported for separate profile components or the results for groups of pupils can be combined across profile components to give results for a subject as a whole, or a number of profile components can be combined to give a pupil's achievement for one subject area or a number of subjects. In order to facilitate the reports of assessment it is proposed that 10 levels be established to cover the full range of progress.

The Task Group recommends that there be no requirement to publish the results up to and including age 7 because of the large variation in results for the early school years. Results at the later levels are to be available to enquirers but only as a more general statement about a school. The results will be produced by the school and authenticated by the LEA. The LEA will be responsible for supplying information about influencing factors such as the socio-economic nature of the area serviced by the school.

How will the system be phased in? To begin, decisions have to be made about attainment targets and programmes of study in each subject. The tests and tasks will need to be prepared and the teachers trained in their use. It is proposed that the number of tests and tasks that a pupil has to take between ages 7 and 11 be kept to a minimum because of the tremendous load that will be put on primary school teachers as a result of the new curriculum. Training for secondary school teachers will be subject specific.

There is little information on the pupils' role other than attainment of different levels as they progress through their schooling. Teachers are to play an interactive role through the moderation groups in determining levels of achievement. While concern is voiced at the increase in workload for teachers, no support systems are recommended or suggested. Records of Achievement are seen as important but no descriptions are given nor are recommendations made as to how they should be used. The Task Group has addressed its mandate to provide recommendation for assessment and testing. Recommendation re subject matter and records of achievement are left to their respective sub-committees.

North York Report on the Use of Writing Folders

This is a summary of the report of a field study which took place in North York in the 1985-1986 school year. The purpose of the study was to determine the use of writing folders in the classroom at the primary, intermediate and senior levels and whether that use motivated students to improve their writing skills, write more frequently and more creatively; improved the ability of teachers to assess and modify their programs to meet the needs of students; helped students organize their work; clarified the steps in the writing process; encouraged students to accept responsibility for their own work; increased student willingness to share their work; and supplied satisfactory pieces of work for both formative and summative evaluation.

A total of 302 questionnaires were sent out on the basis of one for every 30 writing folders supplied to the schools in the study. One hundred and eighteen were returned from 48 schools. Of the teachers who returned questionnaires: elementary panel - 33% had used folder before and 67% had not; intermediate panel - 35 % had used them previously and 65% not; secondary panel - 50% had and 50% had not. The results were seen as conclusive - 79% of secondary teachers and 88% or elementary teachers and 90% of junior high and middle school teachers indicated that using the folders had helped their students improve their writing skills.

Teachers saw the writing folders as aiding in individualizing a program; increasing their awareness of the developmental levels of their pupils and helping in the delineation of the writing process.

The majority of the teachers saw the folders as motivating their students to write more frequently and creatively (79% of teachers of secondary students, 82% of teachers of intermediate students and 90% of teachers of elementary students).

From classroom observation by the researchers on the project it was concluded that the students were very knowledgeable about the steps in the writing process and the students believed that the folders helped in the organization of their work not only in the

language program but in other subjects as well.

Re: formative and summative evaluation of students' work: the teachers agreed that the writing folders provided satisfactory pieces of work for evaluation purposes: 89% of the elementary teachers; 96% of the intermediate teachers and 88% of the secondary teachers reported the provision of satisfactory work at the formative level. At the summative level 80% elementary, 96% intermediate and 85% secondary level teachers reported on the satisfactory nature of the folder for summative purposes. They were particularly pleased by the provision of an arena for discussion with the students and that more materials were provided on which they could base an assessment.

The development of more responsibility for their own work was seen as resulting from the use of the folders. the percentage of teachers reporting positive changes in the willingness of students to revise and edit their work ranged from 76% to 83%. In addition, the students were seen as asking for less assistance from the teacher(ranged from 62% to 74%). The students were also seen as exhibiting more creativity in their use of the folders than in other activities.

In the primary classes teachers reported that more than 90% of the students showed more willingness to share their work as a result of the use of the folders. About 76% of secondary school teachers experienced more willingness on the part of the students to share with their peers. Intermediate level students were seen as more willing on the whole to share both by letting their work be displayed and sharing with their peers.

The extent of final marking or summative evaluation varied by panel. In most elementary classrooms there was little evidence of final marks on finished samples of writing. At the junior and secondary levels, records of marks were kept by both the teacher and the students. For the most part the writing was marked by the teacher.

The view of the researchers was that the students took pride in the ownership of the writing folders in more than 50% of the classrooms visited. There was a positive feeling in the classrooms. Interviewed students appeared to like the use of the folders.

Although they might be asked often to revise what they had written, none of the students interviewed viewed this in a negative way. Some seemed unaware of the processes involved in creating their writing examples -- the thinking, planning, revising, but most others were able to clarify the steps in the writing process.

Report on Education in Sweden and Denmark

There are similarities and differences in the education systems of Denmark and Sweden. Each country will be discussed separately with references to the other where appropriate.

The following information pertains to Sweden.

1. 9 years of compulsory schooling from the age of 7 to 16 divided into 3 sections.

2. A class will have the same teacher for grades 1 to 3, another teacher for grades 4 to 6 and another teacher for grades 7 to 9. These are the class teachers, additional teachers are sometimes used for specialized subjects such as art.

3. No written reports are issued. Everything is verbal. The teacher may prepare some notes she uses when discussing a child with its parents or someone else but those notes are the teacher's personal property and are not shared unless she/he wants to do so. Interviews are held twice a school year.

4. This type of interview is continued throughout the upper secondary school.

5. A teacher will meet with the teacher who is going to take over the next section of schooling to discuss the class, individuals in the class or work done by the class. Nothing is written down for consumption by anyone other than the teachers involved.

6. If a child is not working at the level expected, a remedial teacher will work with the child in the classroom. If that is not sufficient, the child is removed for part of a day to a smaller group for extra help. If this is not sufficient, there are 'special' day schools available for children with learning or emotional problems.

7. No special consideration is given to 'gifted' children nor is a child alllowed in a class beyond his/her age level.

8. School work has to be organized so 2 or more classes form a working unit which equals a working team that plans, carries out and follows up the work of a unit. Remedial teachers, social welfare staff and medical staff is also associated with a unit.

9. Until grade 7 no flexibility in school program is possible. In grade 7 a couple of alternative courses in Mathematics and English may be offered or a choice of a 3rd language - French or German. All optional subjects must have no sexual bias.

10. Senior levels of elementary school are housed separately. As in Denmark, children are kept together in the same classes throughout all their compulsory school (allowing for moving in and out of an area).

11. Swedish schools are decentralized but are expected to maintain uniformity and an equivalent standard throughout the country. The county education committees use 'visiting experts' to help maintain the uniformity and equivalent standards throughout the country. These experts visit teachers in their classrooms and discuss their programs with them.

12. No marks are assigned for the first 7 years of compulsory years of schooling but they are assigned in years 8 and 9.

13. There are no exams in upper secondary school. In upper secondary, marks are assigned each term on a 1 to 5 level and are in relation to the national norms. This assignment of marks is controversial in Sweden. The pupils' representative council and many teachers of compulsory grades want them abolished.

14. A compulsory school leaving certificate qualifies the school leaver to apply for upper secondary school irrespective of the optional subjects taken during the compulsory schooling.

15. During compulsory schooling each pupil must complete 6 to 8 weeks of practical work life orientation. At senior level this means work experience in various work settings. The work experiences must be combined such that boys experience occupations where women predominate and girls experience occupations where men predominate.

16. An upper secondary school certificate is awarded after at least the completion of a 2 year line of study including specific amounts of Swedish and English. This certificate gives general eligibility for higher education. For some areas of higher education a third and sometimes a fourth year is spent in the upper secondary school taking further areas of study.

17. While compulsory schools have no centrally-compiled tests measuring achievement of individual pupils, there are standardised tests for some subjects (Mathematics and Swedish) which are used to measure the achievement of a class or a whole school compared with the country as a whole.

18. Teachers are trained to work only at one of the 3 levels of compulsory schooling and are not allowed to work at another. (Upper secondary school teachers are university graduates with specializations in at least two areas). New legislation is pending which will require higher levels of credentials for compulsory school teachers and will then allow them to teach at a variety of levels.

19. Teachers teach. Yard, cafeteria or extra curricular duties are not the responsibility of the teacher.

20. The more qualified the teacher, the fewer periods he/she has to teach.

21. Free dental and medical care is provided by and in the school.

22. All children through to the end of upper secondary school are supplied with a free hot lunch.

23. Free day care for children under 7 is of a very high quality but space is limited so there is usually a 2 to 3 year waiting list.

The prime difference between schooling in Sweden and Denmark is in the area of examinations and records. There are a few other differences which will be discussed below. The information on Denmark comes from personal accounts by teachers, principals and other school administrators while much of the information on Sweden came from official publications.

1. As in Sweden schooling is compulsory from the age of 7 to 16 and there is no flexibility allowed. For example, it would be impossible for a 14 year old to be in a class with 16 year old children.

2. Compulsory schooling is seen as continuous from 7 to 16 without the three sections the Swedes use. One teacher is assigned to the children in grade 1 and continues with them to the end of their compulsory schooling. Additional teachers may teach them specialized subjects as well. But he/she is responsible for them and is seen as a social support for them.

3. There are no exams during the period of compulsory schooling.

4. Meetings are held twice a year with parents to discuss a child's progress. Written reports are prepared for and with the aid of parents. A continuous record is kept of the child's experiences during the 9 years of compulsory schooling. These records are kept by the headmaster and can be accessed by the parents but are otherwise confidential (as required by law). Teachers, pupils and parents provide input for the records.

5. Children are free to choose what they want to study within a subject area (with the guidance of the teacher). As one teacher said "They usually end up choosing to study the book I wanted to use anyway."

6. Classes are small. We did not see a class bigger than 15 to one teacher but were told they sometimes went up to 23. Teachers, principals and pupils address each other by first names.

7. In the Gymnasium, each class is presented with the teacher's plan for each subject. The students can elect to accept, reject or modify the teacher's plans. Although it is hoped the same body of knowledge will be covered by the different classes in the same subject, the materials used often differ e.g. a French text describing experiences of a War correspondent in Vietnam versus the story of an upper middle class family in France.

8. Mathematics in the Gymnasium follows 2 streams: the Math/Physics stream and the Math/Biology stream. Fewer girls than boys take the Math/Physics streams. A network of women has developed in Danish education to encourage more girls to take the Math/Physics stream.

The prime difference between Swedish and Danish education lies in the examination system. The Danish system is a very rigid one. the following comment was made by the

person describing the system: "It's healthy for a system that is as flexible as ours is to the end of the Gymnasium that there be a very rigid exam system which requires a student to test his/her mettle in the exam battlefield."

The Danish Exam System

1. Exams are set by a small exam committee made up of experts in the subject area. Consultants who are part of the exam committee visit schools during the year to see what is being taught and help young teachers prepare the students in their third year of the Gymnasium for the coming exams. Starting in December of the school year preliminary examinations are given to help in that preparation. Further examinations may be given in the Spring if the teacher feels the classes need them to prepare for the final examination at the end of the school year.

2. The final exams are set in late April/early May.

3. A set of exams in each subject is sent to the headmaster of each school by special courier a week before the examinations will occur. He/she has that time in which to mount any objections. If there are objections, he/she consults with the consultants and they work together until they can come to consensus about the exam in question.

4. All schools do the same exam the same day at exactly the same time. Until the exam is given out it is kept in the school vault. When the exam is finished the papers are collected, placed in a sealed envelope and returned to the school vault until the special courier picks them up and returns them to the Ministry of Education for scoring. (Teachers chosen to score the exams are allotted 30 minutes for each set and are paid on that basis).

5. Every year one subject is chosen for Oral examination in addition to the written exam. The choice of subject is not known until the last day of school. The classroom teacher examines his own pupils, one at a time in the presence of another teacher who is an expert in the area and from another school. This other teacher may also ask questions of a pupil but only after having asked the pupil's teacher for the permission to do so.

6. The Oral exam is designed on the basis of information submitted by teachers in December detailing what they have covered on the subject in the last 2.5 years of school.

7. Prior to doing the oral exam, the student is left in a room to prepare him/herself using whatever aids the student considers necessary. Approximately 30 minutes are allowed for this final preparation. Each subject area has a number of subsets that are numbered. The pupil chooses a number and then finds out what area of a subject the examination will cover. For example, English #6 = lyric poetry.

Systematic, Cumulative Records of Achievement

by

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Abstract

Educators are constantly looking for better ways of evaluating a student's work. It is because of the interest in improving methods of assessment that Records of Achievement have attracted attention. They provide a systematic, cumulative view of a student's achievement over time and thus are seen as offering a more complete and satisfying vehicle for evaluation. This article discusses Records of Achievement as they have been and are being used in Britain. The sources used may be found in an annotated bibliography compiled by one of the authors and available to interested parties.

Systematic, Cumulative Records of Achievement

The cumulative record of achievement (RoA) is just that - an accumulation of performance records for individual students. Interest has focused on the *record* as a form of assessment which provides more extensive and equitable information on students than can be obtained by examinations alone but the process of compiling and using the record is proving to be as important as the product. The references used in this article are a selection from an extensive annotated bibliography prepared by Mary Rosser for the Educational Evaluation Centre of the Ontario Institute for Studies in Education. The bibliography traces the history and evolution of cumulative records of achievement in their many guises as profiles, portfolios, and writing folders. There are articles in the bibliography that describe the RoAs and their different forms in detail, describe their usage and the populations for whom they are used, discuss the pros and cons of their usage and predict their future useage. Almost all of the articles have appeared in British publications and are still available either as books or articles in library collections.

A measure of the interest in them is their intended use by the Department of Education and Science (DES) in England and Wales. It is the intent of the DES that there will be a national curriculum in place by 1990 and that records of achievement will be an integral part of the reporting of results (Task Group on Assessment and Testing, 1987). The *record* is seen as being able to fill a gap that the public examination has created. Records of achievement will provide certification of attainments for the 40+% of students in the U.K. who are currently leaving school without doing the public examinations and therefore without any certificate of attainment. In July 198 4, the DES announced that:

> The Secretaries of State hope it will be possible to establish throughout England and Wales, arrangements under which all young people in secondary schools will have records of achievement which they will take with them when they leave school, a summary document of record prepared within a framework of national policy which leaves scope for local variations

Ten million pounds have been allocated to fund and evaluate nine pilot projects (James,

1988), and the government expects all secondary schools to have some sort of record of achievement in place by the 1990s. The final report from PRAISE (Pilot Records of Achievement in Schools Evaluation) is in press as this article is written.

The use of records of achievement in the U.K. schools has been a subject of study since the late 1970s (Hicks, 1986). Many local education authorities (LEAs) are actively promoting the use of profiles as records of achievement. A variety of systems exist in the U.K. and as more interest develops in their use more research is being done. A number of reviews have been included in the bibliography. There is a detailed analysis of an early project, the Scottish 'Pupils Profile Project' (Broadfoot, 1980), an overall view of the profile movement in England and Scotland(Broadfoot, 1986a) and a comprehensive review of the issues and the use of records of achievement (Broadfoot,1986b). This last mentioned book brings together a number of articles written by specialists in the area who look at the concept's past, present and future and its positive and negative implications. More recently, the many groups appointed by the Secretary of State for Education and Science to prepare documents in preparation for the National Curriculum have been submitting their reports. The report of the Task Group on Assessment and Testing (Task Group on Assessment and Testing, 1987) has recommended

> ...that the basis of the national assessment system be essentially formative, but designed also to indicate where there is need for more detailed diagnostic assessment.(para. 27)

The distinction between formative and diagnostic assessment seems to be one of scale and emphasis. The results of assessments can be used in a generally formative fashion but the diagnosis of specific learning difficulties may require more detailed investigation with the individual pupil concerned.

Many of the teachers who have been involved in the Records of Achievement pilot work have recognized the importance of the formative possibilities of the process rather than the product of asse t. They see the records as a vehicle for the process and for involving pupils in self-assessment as an integral part of the assessment process. For-

mative assessment using RoAs may be viewed as having four components: teacher assessment with some input from the pupils; pupil self-assessment with help from the teacher; pupils' self-reflection on their progress plus input from their teacher; and pupils' reflection on the curriculum providing feedback to the teacher. In all four components, teacher and pupil are involved together to some degree and the process is ongoing throughout the whole school year.

Records of achievement are in an early stage of use and all problems have not been resolved. There is a basic tension between making curriculum objectives and assessment criteria more obvious in the belief that a clear statement of objectives will improve learning versus encouraging self-reflection and more concrete and individualistic approaches to curriculum and assessment in the belief that self-knowledge and intrinsic interest are the keys to learning. Involving pupils in their own assessment as an ongoing process is new and unfamiliar to most students. They need to be encouraged and assured that they will benefit from the process.

While cumulative records of achievement are not a new phenomenon, they have not usually included a self-assessment component. They have been the preferred method of reporting on a child's performance in the primary schools for many years. Unfortunately, inconsistencies in reporting procedures and in the composition of the records has created concerns (Fairbairn, 1986). Their use in secondary schools has generated some negative responses (Hicks, 1986).

The interest in records of achievement for assessment is widespread and spreading. Not only in Britain but in countries such as France, Sweden, and West Germany (Neave, 1980) RoAs are being used to look at the achievement of pupils. In Ontario, the English Curriculum Guideline requires the use of writing folders to document pupils' writing achievement. Many issues have yet to be resolved in the U.K. before there is general acceptance of them by teachers, pupils and the public-at-large, But perhaps we in Canada will benefit from their extensive work.

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New and Comments from OISE's Educational Evaluation Centre

No. 45, Winter 1988-89

e+m newsletter

The Maturation of Educational Measurement

This issue of E+M Newsletter is devoted entirely to "Records of Achievement", teaching and learning tools that can also provide improved means to evaluate what students have attained. Sometimes called "portfolios" or "profiles", they are general versions of the Writing Folder recently mandated for use in all grades of Ontario language classrooms. Schools in England, Scotland and Wales have been experimenting with RoAs for more than 10 years, and we draw heavily on that experience. An introduction by Les McLean sets the stage for excerpts from a forthcoming book by Andy Hargreaves and from a recently published book by Hargreaves and colleagues. These are followed by an annotated bibliography prepared by Mary Rosser.

Educational measurement, especially the measurement of school achievement, may finally be breaking out of the testing box. Even primary schools have been drawn into the box in recent years as standardized tests are increasingly looked to for evidence that children are learning in schools. They have become virtually the only criterion in many states of the USA. The standardized tests are not used for marking in Canada yet, but they influence special education and gifted placements and take on greater and greater weight in higher grades. By the time we get to the middle school, marks are determined substantially by teacher-made tests, and in secondary school test scores are equated with achievement. Even more abstract percentages are favoured as summary marks, although no one can explain what they are percentages of. The numbers are administratively convenient and permit difficult choices to be made (scholarships, university admissions) on seemingly objective grounds.

The status of scores and percentages is being eroded, however, because they have failed to deliver what has always been claimed for them—that they would help improve teaching and learning. The claim that tests provide teachers with information to improve instruction has proved to be false. In spite of vigourous efforts to create so-called "criterion-referenced tests", the pedagogical relevance of test scores is so low as to be negligible. They remain useful for ranking the students from high to low on arbitrary and ill-defined scales, usually with far less accuracy than is ascribed to them.

Administrative convenience and concealment of hard value judgements are only two reasons for the popularity of test scores. Even crude ones are related to learning, and measurement specialists have flogged them to educators with the zeal of soap sellers. These inducements are quite naturally irresistible when no reasonable alternative is presented. Records of achievement have reached the stage where they can take over from tests (as has the Writing Folder, where the test competition was not credible), in that the RoAs can include test scores in the record. By putting test scores in a meaningful context, the RoA might actually make tests useful. The evaluation of 10 pilot schemes in England and Wales has established a firm base, and RoAs are clearly tools that should be tried by teachers at all levels and in all subjects. The research has highlighted difficulties to avoid as well as advantages to be gained, as will be seen.

The following article is excerpted from a forthcoming book, Curriculum and Assessment Reform *(Open University Press, Milton Keynes, England), by Andy Hargreaves, recently arrived from England to take up a new position in the Department of Educational Administration at OISE. He was a member of the Steering Committee of the Oxford Certificate of Educational Achievement and was involved in evaluating pupil profiling within the Technical and Vocational Education Initiative. The article outlines and comments on approaches to assessing and recording pupils' personal qualities and achievements, along with the role of the pupil in that process.*

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On November 28, 1983, the British Secretary of State for Education and Science pledged ten million pounds to support the development of Records of Achievement for all school leavers, to include the assessment of skills, personal qualities and achievements beyond the usual subject attainments. One of the dominant reasons for developing Records of Achievement was the enhancement of pupils' motivation. A second factor was "to offer pupils a certificate which is recognized and valued by employers".[1] These two purposes, motivational and selective, are fundamentally incompatible in important respects.

It is commonly assumed that employers will normally be among the major users of a student's final (i.e., summative) Record of Achievement and of its personal record component in particular. As the Records of Achievement initiative has gathered momentum and gained a national impetus, the practice of including employers in the design of such records has therefore become increasingly widespread. Within a political and educational climate where industrial values are attaining increasing force and respectability and where they make up an important part of the context of educational reform, it is easy to understand why educators are considerably more eager than they once were to encourage employer involvement in this and other innovations for the secondary age range, and why they are keen to design those innovations in such a way as to be "user friendly".

Employers have grown increasingly dissatisfied with the present system of examinations results, supplemented by confidential references, as a basis for selecting new employees. Successful performance in examinations has had to be interpreted by employers as an indicator of qualities of perseverance, commitment, motivation and so forth, when more direct information on such personal qualities would often have been preferable. Employers have begun to express cautious interest in a more extensive system of documenting pupils' personal achievements than most current forms of assessment allow.

This shift in attitude and orientation among employers towards a recognition of young people's personal as well as academic qualities creates points of difficulty. These are to be found at both the summative and formative stages of the recording process.

The Summative Statement

The effectiveness of systems of recording in meeting motivational and selection needs has varied greatly with the type of system adopted. The format that the final, summative statement takes falls into one of four broad types: personal recording, grid profile, comment bank, or open-ended prose summary.

1. Personal Recording

Most systems of pupil self-recording derive from a model developed in the late 1960s by Don Stansbury, the Record of Personal Achievement. Variants and derivatives include Stansbury's own later version, the Record of Personal Experience, and the Schools Council's Pupils' Personal Record. The various schemes revolve around entries made by pupils on a variety of headed cards— Hobbies, Family, etc.— which are then stored in a file controlled by the pupil and to which access can only be gained with the pupil's permission. These systems have met with some success in improving pupil motivation, particularly among the less able, for whom most of the schemes were initially and primarily designed. The privacy and control afforded to these potentially disaffected pupils has almost certainly been helpful in this respect.

Against the success of the schemes in *motivating* many of the less able, must be matched their virtual worthlessness to employers as aids to *selection*. The sheer bulk of the material and the difficulty of knowing just what sense to make of its voluminous contents has seriously undermined the credibility of personal recording systems with employers. Moreover, when schemes of personal recording were extended to include the more able, this group had serious doubts about the schemes' value and their parents were often anxious that the schemes presented a serious and damaging distraction from "real learning". It would appear that for the more able pupils success through formal selection via the conventional external examination route at 16+ is motivation enough. Where success in conventional exam-based selection is unlikely, schemes of personal recording make a strong compensatory contribution to the development of pupil motivation, but they scarcely improve the process of selection at all.

2. Grid Profile

The Scottish Council for Research in Education led the way in devel-

oping profile systems.[2] Elsewhere profile grids have perhaps been most widely used with the 16 to 19 age range, the major initiatives being made by the Further Education Curriculum Review and Development Unit (FEU), the City and Guilds 365 scheme and the Manpower Services Commission. Most grids include a list of qualities (e.g., leadership, initiative, punctuality) or skills (e.g., talking and listening, use of powered machinery) and an assessment of whether and how far pupils possess those qualities or have mastered those skills. Such systems of evaluation are usually teacher-dominated but there are a number of important exceptions (e.g., FEU) where pupils participate in and negotiate the construction of their profile with their teachers.

Of all the systems of recording personal achievements, employers seem to respond best to these. They are brief and easily scanned; they are standardized across all pupils participating in a single institution and in some cases across many institutions; and the skills and qualities listed bear at least a superficial resemblance to those in which employers have an interest.

From the employers' viewpoint grid-type profiles are simple and relevant. However, an assessment and recording system neatly tailored to the needs of employers may be less than beneficial in boosting pupil motivation. One of the most distressing features of the operation of grid-like profiles is that in many cases they seem not to increase pupil motivation at all but rather to depress it still further. It is not difficult to predict the effect upon a pupil of ticks being consistently placed in boxes which attest only to the most elementary levels of skill mastery, especially when the pupil is witness to and at least nominally involved in the production of this authoritative statement of his or her apparent incompetence. The very descriptions of elementary skill mastery in some of the grid-type schemes only served to undermine pupils' sense of worth.

Although developers and adopters of grid-type schemes of profile assessment have been at least as interested in improving the motivation of pupils unlikely to succeed in conventional examinations at 16 as they have been in providing information of use to employers, in practice it seems that once again motivation needs and selection needs are in conflict with one another. Getting pupils to underwrite their inability (or unwillingness) to succeed in employer-desired skills and competencies will do little to improve their motivation or their sense of worth. Grid-type profiles seem likely to score high on selection but largely at the expense of pupil motivation.

3. Comment Bank

Comment banks have been widely discussed and developed as a serious optional form for records of personal achievement. They consist of pre-selected statements which identify beforehand the significant areas in which recordings are to be made and the precise way in which (indeed, the precise words through which) this is to be done. The teacher (in some cases with the student) circles or ticks an appropriate category under headings such as "attitude to people", "attitude to activities", and so forth. These coded statements are then combined, often with computer assistance, to create a more extensive, continuous prose statement about the student. What eventually appears as an open, continuous summative statement is in fact compiled from an assemblage of numbered categories. It is in essence a disguised grid. In comment banks, student involvement is in effect reduced to making selections from lists of statements which, although they contain options, are not themselves negotiable and are not of the student's own making. Such sacrifices of personal involvement and authorship, such confiscations of the student's own voice and declaration of identity, might bring about certain short-term gains in organizational efficiency and employer relevance, but the sacrifices made are probably quite damaging to the motivational purposes that Records of Achievement are intended to fulfil.

If starting points are needed, or a list of possible areas to probe when discussion flags, then what is required is a supportive and suggestive prompt sheet, an optional tool to *stimulate* and *extend* the open-ended and two-sided process of recording students' positive achievements and experiences. The comment bank, however, constrains, contracts and closes down discussion rather than extending and enabling it.

4. Open-Ended Prose Summary

As a way of trying to achieve a more equitable balance between motivation needs and selection needs, and in a way that will optimize the fulfilment of each, a number of schools and consortia of examination boards have run trials of more open-ended yet succinct prose summaries of pupil achievements in and out of school. In these there is at least some possibility that a Record of Achievement could meet motivation needs by affording a more rounded and positive picture of a pupil than seems feasible in grid-type schemes, and by involving pupils themselves in the long and continuous formative process of self-assessment and reappraisal which many see as essential to the construction of the final document. Moreover, it is also possible that employers *might* be persuaded to see the selection implications of a document of no greater length than, say, one page—if only for the purposes of interviewing applicants.

In the succinct prose summary of

pupil achievement, then, we may have a form of summative statement which does not pose too many threats to the enhancement of pupil motivation and which does not appear to be unduly prejudicial to the interests of employer selection.

The Formative Process

It would be unwise to assume, however, that the construction of an appropriate summative document will, of itself, resolve the motivation/selection dilemma. All that the construction of a concise yet open summative document may do, in fact, is to displace that dilemma into the detailed process of interaction between teachers and pupils through which the final document is ultimately constructed. It is in this process that pupil motivation needs or perceived employer selection needs are likely to make themselves felt most powerfully and decisively.

What meanings will teachers bring to their encounters with pupils when assessments are negotiated with them? The difficulty for pupils and tutors here, in knowing just what to record, is that the kinds of qualities employers value and wish to see schools record are often not altogether the ones that schools themselves promote, or that some of their pupils deem to be important.

So long as the activities and experiences which pupils record and wish to record have the ring of such qualities as leadership, loyalty and obedience that employers value, so long as their forte is with the piano, scouting and so forth, then there is likely to be little conflict of interest or purpose between the pupils' own needs to declare and define their identity and the interests of employers in identifying young people with qualities they regard as appropriate for employment. But how will teachers react to activities that do not chime so sweetly in the ears of employers, activities that suggest dissent (such as feminism or peace campaigning) or to ones that imply nonconformity (such as Rastafariansim)? Here pupils and their teachers are in a quandary: whether to define and declare interests and identities, however unconventional, even at the risk of prejudicing employment, or whether to edit personal records so as to present a good impression to employers, but at the cost of concealing, suppressing or falsifying important aspects of pupils' own identities.

Declare pupil activities and involvements, however unconventional, and you will probably enhance pupils' motivation, but only at the cost of their job prospects. Stick to recording only clearly "reputable" activities and achievements and you will communicate a more positive sense of a pupil's employability, but only at the expense of failing to declare, and therefore implicitly denying, vast chunks of the more unconventional pupil's experience and identity. Whereas poor performance in conventional subject examinations possibly labels a pupil as an academic and intellectual failure, the public excision of large parts of his or her identity entails failing that pupil utterly as a person. Thus, the more all-encompassing the assessment, the more damaging will be the consequences for the identities of those more unconventional pupils who are subject to it, even more so if they actively participate in the construction of that assessment, if they actually underwrite this public statement of apparent personal failure. Clearly, when pupils and teachers are playing for stakes as high as these, for declarations or denials of personal worth, no less, the task of identifying the means which different types of pupils and teachers attach to the recording and assessment process, and the ways in which these meanings are negotiated between them is an urgent priority.

* * * * *

In the conventional examination system, it seems that with less able pupils selection needs and motivation needs are very much at odds. Whether restructuring of the examination system will alleviate these difficulties remains to be seen. But how sad and ironic it would be if more open forms of assessment, one of whose central purposes is to provide alternative ways of generating pupil motivation *despite* the exams, actually turned out to depress motivation still further among many pupils, particularly the unconventional. If we are to stand any chance of avoiding these difficulties, a number of policy priorities seem worthy of further exploration.

Most controversially, perhaps the most satisfactory solution to the dilemma, would be to remove one of the parties engaged in this conflict, that is, exclude the employers. It is customary, indeed it seems to be almost obligatory, to involve employer representatives in the construction of Records of Achievement, and to regard them as one of the major users of such records. One cannot help but wonder whether the extent of employers' involvement might be far outweighing their practical importance. With so few students now going directly into employment at 16, and so many going on to further education or training, employers are scarcely users of records of personal achievement. Other than for reasons of political appeasement, then, there would appear to be few grounds for their continued inclusion. Certainly, schools and exam boards and the like would do well to ponder the importance they attach to employer involvement, and the possibly negative implications of such involvement for the recording process and the motivational goals it is designed to achieve.

Short of strategies of exclusion of employers, however, the resolution of these difficult dilemmas, of these important value questions, will

come to rest on the professional judgement of the individual classroom teacher. In making complicated philosophical and social judgements about what are acceptable and unacceptable activities for pupils to declare and record, teachers will need to be very much aware of the value questions involved to be able to reappraise their own values, to be aware of the dangers of stereotyping and to be able to monitor the effects of their own value assumptions on the recording process.

The initiatives to develop records of personal achievement for secondary school pupils have the potential to realize a number of long hoped-for and worthwhile human ideals in education concerning the development and personal growth of young people and the encouragement of their own active involvement in that development. But, as I have shown, the initiative is vulnerable to a range of problems. Dispassionate evaluations of this initiative will highlight the possibilities, allow us to gauge the seriousness of the problems, and indicate ways in which they might be overcome. This is why research on this initiative as well as development of it is such an important priority.

Notes

[1]DES/Welsh Office (1983). *Records of achievement of school leavers: A draft policy statement*. London: HMSO.

[2]Scottish Council for Research in Education. (1977). *Pupils in Profile*. London: Hodder & Stoughton.

Records of achievement are designed to serve many different purposes. Much of their strength and popularity comes from their apparent capacity to meet many of these purposes simultaneously. In their book, Personal and social education: Choices and challenges *(Oxford: Blackwell (Basil) Publisher (1988), Hargreaves et al. examine some of the more commonly stated reasons.*

1. Records of achievement propose to *give genuine recognition to the whole range of pupils' abilities and achievements*, not just academic ones. Conventional examinations tend to focus on just one aspect of achievement– cognitive-intellectual achievement. They have not been so successful at assessing and recognizing practical achievements, and even less so at assessing and recognizing personal and social achievements. School reports have traditionally suffered from the same kinds of drawbacks and give parents only minimal information about how their children have responded to their school experience.

In the early stages of development in profiles and records of achievement much of the attention focused on the compilation of a final document of personal record that can be presented to employers and other "users", and on the benefits of a more comprehensive system of recording and reporting what young people have achieved in school. Discussion about such a *summative* document or report and the form that it might take is, however, often allowed to obscure what may well be the more educationally significant *formative* stage of appraisal and review wherein educational experiences and the pupils' responses to them are discussed, evaluated and negotiated, and new targets are set and agreed upon for the future. It is this process of continuous appraisal and review of personal experiences, achievements and difficulties that perhaps forms the very core of records of achievement.

2. By *recognizing and assessing personal and social achievements* in particular, it is hoped that records of achievement will draw greater attention to them and *give them more emphasis in the school curriculum*, increasing the educational importance attached to them.

3. By broadening the areas of achievement that are recognised, rewarded and assessed, it is hoped that profiles and records of achievement will also help *motivate* pupils more in their schoolwork (particularly those traditionally regarded as "low achievers" or "academically less able") by *giving them greater experience of genuine success*, and recognizing such success when it has been achieved.

4. Such motivation, it is felt, will also be enhanced by *giving pupils the opportunity to define and declare their own identity* as a way of increasing *their self-awareness and independence*, aided by the fact that the pupils compare their performance against themselves, not against one another.

5. A common view is that pupils' motivation will also be assisted by *involving them more in their own assessment*. This will not only increase self-awareness, it is claimed, but encourage pupils to *take more responsibility for their own learning* also, if they themselves see that they have some positive and influential stake in it.

6. Self-assessment not only boosts pupil motivation. It is hoped that a more formalized system of pupil self-assessment, and a way of making these assessments available to teachers, will help teachers improve their diagnoses of pupils' learning difficulties and make teachers more effective in their daily work.

7. Schools and teachers begin to realize that assessment is no longer simply something that takes place when a piece of learning has

been completed. *It becomes a part of the learning process* itself, a way of providing the teacher with extra information to help the pupil, and a way of providing the pupil with feedback to help improve his or her performance.

8. Self-assessment involves reflecting on one's own achievements and shortcomings. But to do this realistically, one has to assess *the context of those achievements* too, of what one is achieving *at*, how much help is being provided, and so on. Pupils will increasingly become involved in assessing the nature and quality of what is being offered, of what is being taught and how it is being taught. This poses fundamental challenges to the teacher-pupil relationship, to the teacher's traditional classroom authority. It puts the teacher in a position of having to continually assess the worth or appropriateness of what and how he or she is teaching.

9. As pupils become more independent and take more responsibility for their own learning, it is anticipated that they will have more of a say in that learning, in deciding what they are taught, in making choices about their own curriculum. In this sense, records of achievement imply large-scale *changes*—not just in the teacher-pupil relationship, but ultimately *in the entire curriculum and organisation of secondary schooling.*

10. Profiles and records of achievement promise changes for more than just particular, identifiable groups of pupils. In the DES policy statement, they are not seen as a reform that should be restricted to the "less able"; nor are they specifically targeted at the broad middle ability range of pupils; nor are they intended solely for middle and high attainers. Rather, they are a reform targeted at all secondary pupils, whatever their age and ability. In this sense, of all recent government initiatives in education, records of achievement is the most *genuinely comprehensive.*

Systematic, Cumulative Records of Performance

Records of achievement have become an important subject for British education, and many articles and books have appeared in the past 10 years. An annotated bibliography, "Systematic, Cumulative Records of Performance", has been prepared by Mary E. Rosser for the Educational Evaluation Centre. A selection of seven references from the 39 in the bibliography is presented to illustrate the material covered. The annotations are intended to give enough of the flavour of each of the articles that the reader can easily decide whether the reference will be of value. E+M readers may obtain a copy of the complete bibliography by writting to Mary E. Rosser, Educational Evaluation Centre, OISE.

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Broadfoot, P. (1986). Profiling and the affective curriculum. *Journal of Curriculum Studies*, 19(1), 25-34.

This article provides an historical look at the development of the profile movement in England and Scotland. The relationship between the affective domain and profiles is discussed. The author states that little research has been done on the implications of profiles on the teaching/learning relationship or on the effectiveness of profiles as an assessment instrument or on the contradiction that may exist for some profile systems between the formative and summative functions of profiling.

Broadfoot, P. (Ed.). (1986). *Profiles and records of achievement. A review of issues and practice.* London: Holt, Rinehart & Winston.

This book, written by experts in the field, is a review of the issues and practices concerning profiles and records of achievement in British schools. The book is divided into three parts. Part 1, Personal Perspectives, includes the first three chapters of the book. Each chapter is written by a different person who has been intimately involved in the early development of pupil profiles. A fourth chapter is written by N. Baugart of Sydney, Australia, who presents an outsider's view of the profile movement. Part 2, Putting Ideas into Practice, describes various "records of achievement" systems which have been piloted in school settings. Part 3 is a critique of "records of achievement", which looks at the positive and negative aspects of the concept.

Broadfoot, P., Nuttall, D., James, M., Stierer, B., & McKeeking, S. (1987). *Pilot records of achievement in schools evaluation* (Interim Evaluation Report). Milton Keynes: Open University, School of Education/Bristol: University of Bristol, School of Education.

This is an interim across-site report of the nine DES/Welsh Office-funded pilot schemes using records of achievement. The report is issues-focused. It looks at both the research reports being produced by each scheme (often from more than one school) for the Records of Achievement National Steering

Committee and the interim reports from the local evaluators of what they have seen in the classrooms and learned talking to teachers involved.

Hargreaves, A., Baglin, E., Henderson, P., Leeson, P., & Tossell, T. (1988). *Personal and social education: Choices and challenges.* Oxford: Blackwell (Basil) Publisher.

Chapters 5 and 6 are of particular interest. Chapter 5 discusses personal recording, diaries and log books, their history of use in the classroom, the various forms they may take and the audiences for whom they are intended. In Chapter 6 many reasons are given for the current popularity of records of achievement in the British educational system. Although some reservations are expressed concerning invasions of privacy and their possible use as surveillance instruments to track the population, the overall view is a positive one.

McGovern, P. (1986). The INSET needs of a school developing a profiling system: Part 2 - Developing the profiles: Making INSET work. *The New Era*, 67 (3), 77-79.

INSET stands for inservice education and training. Part 1 deals with inservice education and training as a whole; Part 2 deals specifically with the needs of teachers embarking on a system of profiling as an assessment instrument. Profiling demands new attitudes and more effective skills from teachers than most other forms of assessment. In order to meet those radical changes the individual learning milieu of a school has to be changed. To accomplish this a 16-week programme of one day per week was organised for coordinators, and small groups of teachers were involved in later sessions. The teachers who will be involved in actually doing the profiling were encouraged to voice opinions and make suggestions.

McLean, L. (1985). *The craft of student evaluation in Canada.* Toronto: Canadian Education Association.

Includes a look at different methods of assessment. A number of recommendations are made. Pages 44-45 deal with profiles/writing folders/dossiers used in Britain and France as instruments for keeping track of achievment.

Stevenson, M. (1983). Pupil profile - An alternative to conventional examinations. *British Journal of Educational Studies*, 31(2), 102-116.

Almost all of "our present assessment procedures have been directed towards cognitive outcomes .... The proposals for developing pupil profiles stem largely from a concern that public examinations do not adequately measure or express pupils' developments or attainments." It is the contention of this paper that criticisms of one form of assessment "may not be regarded in themselves as justifications for another form of assessment". There is a need to analyse and critically appraise the claims that are made for such profiles before conclusions can be reached about their use as an alternative form of assessment.

There! The simple test you've been looking for – just dip the kid in and if he turns blue, he's poor

–Times Ed. Supplement 25-3-88

The *E+M Newsletter* is issued twice a year by the Educational Evaluation Centre, Ontario Institute for Studies in Education, 252 Bloor Street West, Toronto, Ontario, Canada, M5S 1V6, as an information service for school administrators, teachers, and guidance workers. Subscription $2.50 per year. Opinions expressed in the *E+M Newsletter* should be viewed as those of the contributors. Editorial assistant: Terry Massameno.

Postscript:

The final report, *Records of Achievement—Evaluation of Pilot Schemes*, by Patricia Broadfoot, Desmond Nuttal and others, was published by the Department of Education and Science in mid-December. The Educational Evaluation Centre will receive a copy and review it in the next issue of *E+M Newsletter*; readers interested in seeing the report should visit the Resource Collection of the Centre (located in Room 11-183) or call for details.

Leslie D. McLean
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Achievement Measures Made Relevant to Pedagogy

Abstract

Conventional achievement tests lack relevance to teaching and learning because they are based on inappropriate subject matter theories and the concept of achievement as trait. Functional language theories provide a base for relevant performance measures, but they also reveal that achievement is context and task dependent. Such dependence makes valid generalizations rare and application of item response models inappropriate. A functional approach here is outlined for mathematics and science in the middle school, where much improvement is needed. Content is carried by realistic problem sets, and achievement is defined as performance, documented in portfolios similar to the writing folders used in language classes.

Pedagogy is defined in the *Compact Oxford English Dictionary* as, "the art or science of teaching." "The art and science of teaching" might be more accurate, or "the art and craft of teaching," but that is another story (McLean, 1985, for example). The purpose of this article is to explore what it means for achievement measures to be relevant to teaching and to suggest how the link can be made stronger. First, achievement measurement will be reviewed and analyzed to sketch out the problem. Next some encouraging progress in making language testing relevant to teaching will be described, which will lead to a final section suggesting how achievement measures can be made more relevant in other subjects, especially science and mathematics.

Limitations to Prevalent Achievement Measures

Achievement is measured at three main levels of educational systems – the national level (provinces and territories in Canada), the local authority

(board or district), and the classroom level. At the national and local authority level, monitoring standards and accountability are the primary motivations, though the improvement of instruction is often cited. Some provinces, Alberta and British Columbia, for example, do construct achievement measures related to their own curricula, but so far there is no confirmation that teachers find the results directly applicable to their own teaching. Teachers have to make a long leap of inference from scores on common tests to the challenges of their own classroom, and the authorities who mandate the testing consider it sufficient if broad problem areas are identified for the professionals to solve.

In short, it is believed that monitoring and accountability do not require strong pedagogical relevance, a position that can only be defended if the measures used for monitoring tap outcomes toward which everyone is (or should be) striving. This defense is difficult if the measures are published tests that overlap provincial curriculum guides only a little, or one-dimensional scales that reflect outmoded concepts of the subject. More promising are province-wide surveys employing large item pools with good coverage of the provincial curriculum and contextual information from surveys of teachers, schools, and students.[1] Such surveys are not common, but the Ontario Ministry of Education has begun to carry out provincial reviews on a five-year cycle, using that methodology. Boards of education are invited to extend the provincial survey to their own jurisdiction by payment of a small fee per school. When extended to the school level (or better, the classroom level), such surveys can have considerable pedagogical relevance. The British Columbia learning assessments are models of such surveys.

To no one's surprise, measurement moves closer to pedagogy as it moves closer to the classroom, but classroom measurement that relies on test scores is still disconnected from teaching. There are two faces to the problem, neither of them discussed in the measurement literature. The first is that tests are based on inappropriate, usually unstated, theories of the subject matter. It may be unfair to blame the tests, because the concept of a theory of subject matter is new to most curriculum developers. Language theories and their application will be discussed below in the section on language teaching and testing. Some preliminary thoughts on theories of mathematics and science content will follow the language section.

The second obstacle to pedagogically relevant measurement is a concept taken over from psychology – achievement as trait. Under the influence of psychological testing, particularly ability or "intelligence" testing, the idea has become entrenched that school achievement has to be captured in a number, a test score. This has led to an enormous literature under the heading of "test theory," not a theory at all but an elaboration of

families of mathematical models for the analysis of test scores. The families, including the fashionable "item response" models, all have one characteristic in common, i.e., they are content free. From the classical model of observed score equals true score plus error to the logistic item response models, the same form is applied to a score said to measure reading comprehension as to a score representing achievement in mathematics computation. Test scores are analyzed by specialists in psychometrics who have no need to know what the test developers have set out to measure.

In the absence of subject matter theories that provide clear definitions of achievement, it is not surprising that achievement is construed as a general human characteristic, a trait that is stable across people and settings. Pedagogy, however, takes place within specific settings, among people who have both shared and unique intentions. Curriculum guides, quite rightly it seems, leave many important decisions to the teachers, with the result that the content and concepts presented to students vary in important ways from classroom to classroom. At its best, this system permits the skills of the teacher to be matched with the interests of the pupils, still respecting overall content guidelines.

The system makes sense, because in spite of constant efforts on the part of confident zealots, no specific content has been identified as the necessary curriculum. Many are now equally confident that there is no necessary curriculum, and hence that the learning required for productive living in any society has to be defined at a more abstract level than the school's operational syllabus (course of study). After several years of work, an Ontario study, for example, has found that "negotiating skill" is a key outcome to be attained through the curricula of the elementary and secondary schools (Russell, 1987). In other words, the school's course of study can be chosen in a valid way from a wide selection of alternatives, much as is now done when schools interpret provincial curriculum guidelines.

Such diversity is incompatible with the concept of achievement as a stable, general trait. The weak predictions provided by trait measures testify to the low utility of such constructs for understanding behaviour. For some, the utility has slipped to zero (Olson, 1986).

> There used to be a thing like verbal ability that explained things. It's gone. At least it's gone for me. All cognitive science is based on the notion that you have set procedures that you use for dealing with domains. Some of those procedures are applicable across domains and so on. And the task for psychologists, as I think for educators and others, is to find out just what that competence is made up of and

> what are the conditions under which you can help people sort out the major dimensions or considerations in that form of competence. There is still talk about spatial ability and verbal ability and so on, but that's a level of description that has very little explanatory value. Explanatory value comes from actually figuring out how they solve this task, or how they sort out what next to put down on their text if they're writing something. (p. 177)

This "explanatory value" is just what teachers seek to help them improve their teaching, what they get from questioning students in class and from homework exercises, but do not get from set tests. Diverse tasks, test items, are grouped by content, sometimes thoughtfully, but the outcome on which judgments are to be based is almost always a single number or score for each person. The thoughtful diversity built into the tasks disappears into the "sacred" test score. In spite of fifteen years of work with criterion-referenced testing, most educators still find meaning in test scores by comparing them with other test scores, in other words, with norms. Test scores tell us in general terms how learning is proceeding, but the combination of item results into a single number severs the link to pedagogy. It appears as if all of the pedagogically-relevant information available from tests is at the item level (Talesnick & McLean, 1987), but even at this level the tests fall short (Leinhardt & Putnam, 1987, p. 585). Measurement textbooks still emphasize the test score, however, giving primacy to summative judgment over formative. If mentioned at all, pedagogical relevance comes in as the unsubstantiated claim that test scores can be used to guide instruction.

It has been implied that inadequate theories of subject matter are one cause of the current predicament – theories of language, mathematics and science, for example – that not only suggest how the topic should be taught but also provide a definition of achievement and prescribe how this achievement should be measured. There is progress in the language field that may show us the way toward pedagogically relevant measurement in other subjects. That is the subject of the next section.

Encouraging Developments in Language Teaching and Testing

Until the second half of this century, language teaching was based on a theory (not well articulated) that the structure of language was basic to its understanding and use. Teachers, therefore, tried to help pupils build up an understanding of structure by means of grammar, syntax, and spelling, and they tested discrete structural elements accordingly. About this time, interest in foreign languages increased dramatically as the global village became a

part of more people's reality. Reading other languages was no longer enough; people had to be able to speak and understand them and to communicate with them. In other words, the function of language began to take precedence over the structure. Writing emerged as a special pedagogical problem, combining the functional and structural elements in ways seemingly impossible to untangle. The pedagogy of writing remains a difficult challenge, mirrored by the difficulty of defining and assessing writing achievement (Oxenham, 1980).

It took several decades for functional approaches to emerge, and they are still emerging. In the late 70s, the new concepts converged in communicative language theories, containing direct implications for teaching and testing (Canale & Swain, 1980). The theories apply equally to mother tongue and to second, third, and other languages, since the emphasis is on the communication of meaning. Structure becomes the servant of meaning rather than the master. Once this shift is made, numerous implications follow, only a few of which can be mentioned:

- Context and purpose are recognized as vitally important. One communicates in a different way to different people in different places for different purposes. Teachers must therefore set up or take advantage of many different settings, showing and explaining why language varies with context and purpose.

- Communication is intimately related to knowledge and information, to the ideas and facts a person already has. Reading and listening are complex interactions between what is being read or heard and what one knows. Meaning does not exist in the abstract but instead is constructed in the process of reading or writing.

- The changes that go with learning are subtle, but they are continuous and cumulative. The pace is slow, happening over months rather than weeks or days, because of the many interactions in the process.

- Valid measurement must therefore involve similarly varied settings and purposes. It must take place over time periods of the order of months and years, and it must be sensitive to cumulative change. Achievement is multidimensional and is task and context dependent.

- Individual differences between students and between tasks will be great and important. Aggregate measures will have little or no pedagogical validity. Systematic, cumulative records of performance, such as the record provided by writing folders, are required.

Where these lessons are taken to heart, testing and assessment take a form which supports communicative teaching methods. The approach to language in the *Assessment of Performance Unit* in England, Wales, and Northern Ireland, for example, includes diverse materials, different writing modes, and linked speaking and writing tasks in several modes (Gorman, 1986; Thornton, 1986). In Ontario, the use of the writing folder has been mandated from grade one to the end of secondary school, and common examination procedures have been installed rather than common examinations at the end of secondary school. An international study of written composition is just being completed, following the collection of ten different samples of writing, and after subjecting them to various analytic scoring schemes. In 1984, the Department of Education and Science for England and Wales endorsed the use of *Records of Achievement*, comprehensive profiles of performance that pupils take with them from year to year and when they leave school (Broadfoot, 1986).

Not all jurisdictions have this view of language assessment. In the United States, the **National Assessment of Educational Progress** (NAEP) has issued a "reading report card," based on a single scale of reading proficiency that extends from age 9 to 17 (NAEP, 1985). The approach already has its critics (McLean & Goldstein, 1988), but it is exceedingly popular with decision-makers who demand simple answers. An American survey of reading performance in an out-of-school population used a broader sample of meaningful materials, but the results were then made to fit the same one-dimensional scale (Kirsch & Jungeblut, 1986).

Implications for Science, Mathematics, and Beyond

When reading and hearing about developments in language theory and language teaching, one encounters a continuous interplay between structure and function. Function, however, is dominant, and structure is an essential support. People learn language naturally (from parents, relatives, others) with little or no recognition of the structures they are learning, but in order to generalize and to make learning more efficient, reference to structure is required. An important discovery was that teaching succeeds best by working from function to structure, and almost not at all in the other direction (Canale, 1983). Structure is now seen as the servant of meaning, not the master. Might this not apply to other subjects as well?

Both science and mathematics teaching are in somewhat of a turmoil. In Canada, two national studies have found only small amounts of science teaching and distressing levels of performance in the general school population (Science Council, 1984; Connelly *et al.*, 1985). Overall achievement in mathematics is not so distressing, but neither is it inspiring (McLean *et al.*, 1987), and the same problem areas exist now as have

existed as long as analyses of the curriculum have been made. The middle school (roughly ages 11-16) is the most problematic, with a great deal of review of arithmetic and little progress in it. Average student performance is poor on any but the simplest applied problems (McLean, 1982). The field would seem to be open for new approaches.

Mathematics and science curriculum guides are marvels of structure – abstract frameworks that organize the parts into a whole. The term **structure** is said to have been introduced to sociology by Herbert Spencer in the 18th century, and it now pervades social science. Structure serves as the unconscious infrastructure of phenomena. Structural linguistics dominated language analysis up to recent times, though it is notable that it was not prominent in semantics. Apparently meaning does not yield so readily to structural analysis. The concept made its way through Durkheim and Radcliffe-Brown to Talcott Parsons, whose functional-structural analysis saw function as a link between relatively stable structural categories. Structuralism has been seen by some as a spectre over social science, because of its ubiquitous use as a vague term (Assiter, 1984). It is similarly a spectre over curriculum where it blocks teachers' and students' view of the functional elements of their subject (as it did in language for many years). This is seen, for example, in the **applications** problems in most mathematics and science textbooks in the form of contrived problems with meaningless settings.

Attention will be restricted here to the middle school, specifically grades 7 and 8, since the problems are well recognized there. In the United States, **problem solving** was declared to be the emphasis for the 80s (National Council of Teachers of Mathematics, 1980), but evidence for implementation is lacking. Functionalists would concentrate on meaningful problems, giving attention to context and purpose, leaving until later the place of the problem in the overall structure of mathematics or science. Half of the students now fail to learn key elements of middle-school mathematics, so there is room for improvement (McKnight *et al.*, 1987; McLean *et al.*, 1987).

The following criteria for selecting school problems are an attempt to capture a functional approach to the teaching of mathematics and science:

1. The problem must have an interesting context that is either already known to most students or is easily recognized.

2. The mathematics or science needed to solve the problem is generally useful and central to the problem. The content is not a trivial or amusing sideline; it has an important function.

3. A satisfying solution is accessible to the majority of students to whom it is presented, but the problem has many more challenging dimensions for able pupils or for the later study.

4. Other versions of the problem are easily accessible for practice and for evaluation without boring repetition.

There is not time to explore the functional approach thoroughly, nor is it yet fully worked out. What is clear, however, is that achievement can be defined as performance on a series of problems that are meaningful to the students. Student evaluation is then properly based on a systematic, cumulative record of performance – a portfolio unique to each student, inspired by the writing folder. The pedagogy to which achievement measurement is to be relevant begins with the context and purpose, introduces the solution as an application of content, and proceeds to related problems in order to seek transfer and generalization. At least in the beginning, no attempt is made to teach problem solving explicitly, but a time is set aside for reflection on the solutions and approaches at the end of work on each problem set. More time is spent on fewer topics, a lesson suggested by several studies in recent years (McKnight *et al.*, 1987; Science Council, 1984). The approach suggests organization of cooperative work in whole class and small groups, an organization strongly supported in recent research (Johnson *et al.*, 1983).

Summary and Conclusions

Missing or inadequate theories of subject matter and an inappropriate concept of achievement have been proposed to explain why prevalent achievement measures, mainly test scores, have little relevance to pedagogy. Functional language theories however, are showing great promise in guiding language pedagogy, and they also suggest related measures of achievement. The theories imply achievement as performance rather than achievement as trait, requiring recognition that achievement will be task and situation dependent. Such measures do not lend themselves to summary by test scores and, in particular, are inappropriate for fashionable techniques such as the application of item response models. Instead, the theories suggest the use of portfolios (reading, listening, speaking, writing, mathematics, and science) as systematic, cumulative records of performance.

Implications for other subjects were found in the concepts of function and structure that underlie communicative (functional) language theories. A functional approach to science and mathematics first sets problem clusters in a familiar context and motivates a solution that is accessible to the students. Further elaborations of the cluster give practice in the key concepts and skills, not striving for understanding of the overall

structures until after the middle school. Records of mathematics and science performance are linked directly to pedagogy. It remains to be seen whether a comprehensive pedagogy can be devised, but achievement in the middle school is sufficiently low that there is room for new initiatives.

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NOTE

1. An example of such a survey is the recently completed *Second International Mathematics Study* (Robitaille, O'Shea, & Dirks, 1982; McLean, Wolfe, & Wahlstrom, 1987).

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The Inductive Curriculum: Mathematics and Science in Context for the Middle School

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The Inductive Curriculum: Mathematics and Science in Context for the Middle School

Recent national and international studies have reinforced the sense of crisis in science education and a feeling that mathematics teaching is languishing in doldrums going back to the turn of the century.[1] There is concern at all levels, and certainly in the middle school--grades 7 and 8, perhaps 9. These years have always been difficult, and many organizational arrangements and curriculums have been tried. Contributing to the malaise is a growing recognition that achievement testing contributes little or nothing to the improvement of teaching and learning. The student evaluations that do guide teaching are carried out with varying degrees of success by teachers in classrooms, with little help or training (McLean, 1985, Stiggins, 1985). Assessments of achievement tell us there are problems but give few hints what should be done about it.

National and international surveys of mathematics achievement, for example, have shown that about half the students are still not able to do simple percentage problems by the end of grade 8,[2] about a third to one-half fail at numerical operations more complex than simple addition and subtraction, and the success rate is rarely as high as 50 percent on any but the simplest word problems (McLean, 1982, McKnight et al., 1987, McLean, Wolfe, & Wahlstrom, 1987). This performance bodes ill for science and mathematics in the secondary school and falls short of that needed in a modern technological society. There is clearly plenty of room for improvement.

The present paper outlines an approach designed to break out of the abstract, rule-driven structures that characterize most present day science and mathematics curriculums. The inductive curriculum has roots going back to Locke, Rousseau and Dewey (Swartz, 1985), but it owes its present

inspiration to those who have reformed language teaching and testing over the past decade.[3] The reforms in language teaching are based on *functional* theories of language, theories that emphasize the purpose of language and the primacy of communication in context. These stand in opposition to *structural* theories that see frameworks for language that stand independent of purpose and context.

Mathematics and science curriculums are not usually analyzed from this perspective, but the formalism and universality claimed for them put them firmly in the structuralist camp. The authors of one study decried the lack of reference to science in society in general, and technology in particular, and dubbed the approach "textbook science" (Science Council, 1984,p. 37). Others have documented how "teachers rarely or never addressed the noncontent components of science in their presentations and academic work assignments" (Mitman, 1987 ,p. 611).

Language teaching, both first language and other languages, reached a crisis in North America about twenty-five years ago, especially in what was then commonly called *foreign languages*. It was no longer adequate to be able to read other languages; people wanted to be able to communicate--to speak with others and to understand what they said. There was also a realization, still unfolding, that a majority of the population were not learning their own first language at all well by being taught the structure of the language. Teaching the rules and their application left many students with poor communication skills, especially in writing. The key that unlocked new approaches was the recognition of the primacy of meaning--structure had to be made the servant of meaning rather than the master.

Meaning is not a fixed feature to be discovered. Instead, meaning is continually in process as individuals interact with their environment.[4].

This view of language revealed daunting complexities, because language has meaning only in context, and context includes knowledge, past experience, manners and mores and more.

The dependence of meaning on context presents a special challenge to the definition and measurement of achievement. Achievement means communication, so every task set to examine someone's ability to communicate, to get the meaning across, has to provide an appropriate context. For example, there must be sufficient detail to inform the examinee who is communicating with whom, under what circumstances, for what purpose. Knowledge of the gender as well as the relative age and status of the participants is usually necessary if one is to choose the most appropriate form of communication. The idea that achievement is context dependent in this complex way is still not understood and accepted by many in the measurement community, but language teachers know it (McLean & Goldstein, 1988). There are fascinating parallels between developing paradigms in language and in science (Weaver, 1985).

The Inductive Curriculum

The objective of the inductive curriculum is to implement functional theories for the teaching of mathematics and science similar to those that shape teaching and testing in language. These theories must also provide a definition of achievement from which measures can be derived and defended. Current guideline topics (energy, light, geometry,...) are used to define the content, but the topics are left tucked inside sets of meaningful problems. The problem sets have names such as, *Making Sense of Opinion Polls* and *The Community Centre Gets a Pool.*

The curriculum emphasizes context and function, building up skills and arriving at (or reinforcing) rules from experience--by induction. It is in this way that the *method* (if one can call it that) goes back to Bacon,

Locke, Rousseau and Dewey, all of whom advocated the use of induction in teaching. The curriculum also borrows from modern cognitive science in the emphasis on meaning and purpose. The two share a common concern with the primacy of the learner's experience in guiding new learning. The crucial assumption to be tested is that more students, especially in the middle school, will learn mathematics skills and concepts by working on problems meaningful to them, problems in which they see a purpose for the skills and concepts.

In the inductive curriculum, students work cooperatively with the teacher, in pairs or in small groups. The objective is for *all* students to apply the prerequisite skills and learn the skills and concepts necessary to solve the problems.[5] Since the objective is for all students to learn the skills, individuals will be set their own problems at an appropriate time in order to evaluate their skill and understanding. Functional curriculums lend themselves best to evaluation via systematic cumulative records of performance, e.g. folders of work completed and marked by the student, the teacher and other students. Such folders are expected to be unique, but minimum contents can be established for marking, so that standards are understood. We now turn to the examples.

A review of mathematics and science textbooks reveals many creative and challenging exercises and problems--as well as many contrived and meaningless ones. The common feature of all of them, however, is the lack of a meaningful context--most often the lack of any context at all. Two examples are given in Figure 1, neither especially good nor especially bad illustrations.

This concern for context and meaning shares some elements with the concern expressed by the Science Council of Canada for *a more authentic view of science* (Science Council, 1984), but in most ways it is quite different. The discussion is as relevant to mathematics as it is to science.

Figure 1: Exercises reproduced from Grade 7 or 8 mathematics textbooks to illustrate neutral or absent context and purpose*

An airplane is flying at 1760 m (represented by +1760) above sea level. A submarine is 185 m (represented by -185) below the water surface. What is the distance between the airplane and the submarine?

Starting at 6 a.m., two buses leve from the same stop. One downtown bus returns to the stop everry 12 minutes, and the other bus returns every 18 minutes. Indicate the next two times that both buses leave this stop together.

Determine the frequency of letters found in a paragraph by tallying. Make a frequency chart and rank order the letters. Which vowel was used least frequently? Which consonant was used most often?

Complete the ordered stem and leaf plot for the following heights (in cm) of boys (girls) on a basketball team.

158, 162, 166, 176, 155, 181, 170, 164
159, 166, 173, 169, 165, 171, 168

Stem	Leaf
15	
16	
17	
18	

---

*_Curriculum Guide 1987_, B.C. Mathematics, Grades 1-8. Examples are taken from Grades 7 and 8.

> The Science Council is concerned with the image of science conveyed by the science textbooks. Research has shown that 'textbook science' tends to be overly standardized and simplified in order to present a smooth road to scientific knowledge. But if science itself is a search for explanation, then surely science education must give students an authentic explanation of the way science works. The Council acknowledges, in general, the accuracy of the scientific knowledge contained in textbooks and has received few complaints about that. The problem lies with the inadequate representation of the scientific enterprise and the consequences of this for students.
>
> A better portrait of science, we believe, should include the following aspects: the history of science and technology, an account of their relationship, and a reflection on the nature of scientific knowledge (p. 37).

The above is a concern for content, rather than format or method (dealt with in other parts of the report). It is often the contrived exercises, however, that are "overly standardized and simplified", since it is difficult to set such problems in a meaningful context. Meaningful problem sets might provide a few glimpses of the history of science and technology (and their relationship), but such content will likely have to be taught directly if a better portrait of science is to be presented.

The Science Council was also concerned about context, as in, "The Science Council believes that the science that is taught to young Canadians should be set in a Canadian context and that this context should include both historical and social aspects" (p. 40). This carries the idea of context one small step farther, since the suggestion is that the context be *explicitly* Canadian. It would be difficult to present meaningful problems without any "social aspect", but as noted above the "historical aspects" might be absent or implicit. Indeed, if problems are to be relevant to the social realities of 12 and 13 year-olds, the settings of the problems have to be contemporary. In the next section we present one approach to this daunting challenge and provide two examples.

Problem Sets

Each problem set is focussed on a major topic (such as ratio, proportion and percent) but necessarily brings in a variety of skills and concepts. Problem sets create a forum for developing *criterial knowledge*, an understanding of what constitutes an interesting, meaningful problem (Bereiter, 1986). The following is a proposed list of required characteristics:

1. The context (setting) of the problems must be interesting and recognizable to students. Realistic settings are required.

2. The mathematics or science needed to solve the problems is generally useful and is central to the solution of the problems.

3. A satisfying solution is accessible reasonably quickly for the majority of the students, but there are extensions that challenge the more able students.

4. Other versions of the problems can be easily generated for practice and evaluation without boring repetition.

To make the discussion concrete, two problem sets will be presented. These were designed for Grade 7 or Grade 8, depending on the curriculum guide and on the previous experience of the students. As in language teaching, meaningful settings take time and space to set out, so the examples take up several pages. There are two versions of any set, (a) the descriptive version presented to the students, and (b) the teacher's guide, containing a brief narrative description of the problem set, the skills and concepts the set involves, prerequisite skills, suggested timing, specific presentation tactics, solutions to all the major parts of the set, and suggestions for evaluation. The brief narrative version will be presented first, then the students' version followed by discussion which will include much of what is included in the teacher's guide.

Making Sense From Opinion Polls

Narrative description. Hardly a day passes without reports of some new survey of public opinion--"Who would make the best Prime Minister?", "If an election were held tomorrow, which party would you support?", "Should the legal age for drinking be raised?". One or two thousand people across Canada or across a province are carefully chosen and asked to answer the questions. The results are then expressed in percentages, such as, "The Conservatives have climbed three points since the last poll, to the highest point since the beginning of the year and the NDP dropped slightly. Thirty-four percent of Canadians would vote Conservative and 25 percent NDP, with the Liberals remaining constant at 41 percent.

These polls, and surveys, which the students can conduct themselves, provide interesting ways to learn what percentages are and how to calculate them. Surprising challenges, and surprising results, are often encountered when the we try to find out whether women answer differently from men, older people differently from younger and the like. Ratio, proportion and percent are covered with plenty of practice in estimating and using a calculator. Extensions to probability and statistics will challenge the best students right through high school and beyond, but there are many interesting results to be found by elementary means.

Students' Version. This is an untested draft of the version to be presented to students. Teachers discuss the problem with the class as a group before students begin to work on the tasks.

Making Sense from Opinion Polls

Businesses such as *The Gallup Poll* and *Canadian Facts* make their money by predicting the future. They ask a thousand or so people a few questions, and from their answers they predict how Canadians will vote

and what they will buy. Choosing the people to ask and getting their answers is called *polling*, the results are called *polls*, or *surveys*. How do they make the predictions? They use science, imagination and lots of simple calculations.

A new poll is reported on television and in the newspapers nearly every day. Some are done just to find out what people are thinking--about free trade, nuclear power or abortion, for example. A few years ago (when there was still Grade 13), the Ontario Institute for Studies in Education (OISE) took a poll of students across Ontario in Grades 7, 8, 9 and 10, asking their opinions on a number of matters and also asking about their plans for future schooling. One reason for the question was to find out if plans changed as students progressed through the grades. Only a few thousand were included in the poll, but they were carefully chosen to be as much like the whole Grade 7 to 10 group as possible.

The first step in making sense of the answers is to *tabulate* them--count how many people gave each answer. Table 1 shows the counts of answers to the question:

In the next few years, I plan to

a. complete Grade 13.
b. complete Grade 12, but not Grade 13.
c. leave school before completing Grade 12.

Problem One: Along the right-hand edge are the total number of students in the survey, in each grade. There were 914 answers from Grade 10, for example, but only 715 from Grade 9. Check the totals by adding the numbers in each row. Then add the numbers in each column to see how many students planned to complete Grade 13, Grade 12 or leave before completing Grade 12. The total number of answers from all grades was 3506. Add the column totals to verify this number (all these totals will be needed for the next problems). How else could you check the grand total?

Table 1: Numbers of Ontario Students in Grades 7, 8, 9 and 10 Who Chose Each Option in a Survey of Their Plans for Finishing High School

Grade	Complete Grade 13	Complete Grade 12 but not Grade 13	Complete before completing Grade 12	Leave Schodltotal
7	729	196	19	934
8	651	264	28	943
9	178	501	36	715
10	667	229	18	914

Problem Two: We don't try to make sense of the counts, because the raw numbers are too awkward. It is good to look them over, however, and think about our questions before moving on. What do you make of the numbers of answers from each grade, for example? Is it reasonable for the number from Grade 9 to be smaller than from the other grades? How would you know? What do you think when we tell you that about the same number of Grade 9 and Grade 10 students were included in the survey? Why is it awkward to compare the counts from one grade with those of another? To get a feeling for the process, you might take a survey in your own class (do it by 'secret ballot'). Perhaps other classes would join the survey. Prepare your own tabulation. We want to know if students have different plans in Grade 10 than they did in Grade 7, but you can get a feel for surveys just by doing it in one class.

Problem Three: The way most people try to make sense of polls such as this one is to convert the counts to percentages. Take an easy example first--express the column totals at the bottom as a percentage of the grand total. This allows us to write something such as, "Sixty-three percent of students in Grades 7 to 10 said they plan to complete Grade 13. Only three percent planned to leave school before completing Grade 12". Percentages make comparisons more meaningful because we are comparing several proportions of the same number. Express the grade totals as a percentage of the grand total and use them to describe how the total number of students who responded to the question were divided

among the four grades. This is just for practice, though. To find out whether plans change from grade to grade, we have to compare percentages who choose each answer *within each grade*. That is the next problem.

Problem Four: Since we want to compare grades, we work separately within each grade and compare later. Start with row one (Grade 7), and express each count as a percentage of the row total (934). Do this for each of the four rows. (How can you quickly check your calculations?) Now study the percentages and see what meaning you can make of them. There is a startling result, which you may have suspected from the counts but which strikes the eyes when you look at the table of percentages. Your result should look like Table 2.

Teacher's Guide. These are comments specific to this problem set. A general introduction to the methodology appears separately. The *Teacher's Guide* is to be refined in cooperation with teachers who try out the curriculum during '88-'89.

Making Sense of Opinion Polls
Draft Teacher's Guide
February 1988

Mastery of the calculation, understanding and use of percentages and proportions are the primary objectives of this problem set. Results of a 1981 survey of Ontario students in Grades 7 to 10 are presented as the *number* of students giving various answers to a question asking whether they planned to finish high school. When the right percentages are calculated, a surprising result is obvious among the Grade 9's.

Discussion of random sampling is probably unavoidable, at least at the intuitive level--the idea of a *representative* sample. It is suggested that students carry out their own survey in order to give them a better understanding of how such numbers are obtained, and this leads to questions about the comparability of samples. It is a golden opportunity to discuss the greater uncertainties associated with small samples, especially

Table 2: Frequencies from Table 1 Converted to Percentages

Grade	Complete Grade 13	= Complete Grade 12 Grade 13	Leave school before but not Grade 12	Total completing
2				
7	78	21	1	100
8	69	28	3	2=100
9	25	70	5	100
10	73	25	2	100
Total	63	34	3	100

non-random ones. Analysis and discussion of a current or recent poll (from newspapers, magazines, ...) extends the set and provides reverse practice (if 1500 people were surveyed and 28 percent agreed, how many people is that?). Published surveys also bring in the concept of sampling error, such as, "The results will be accurate within four points, 95 percent of the time". This opens the way to discussion of probability if it suits class and teacher, but stick with percentages until everyone is comfortable with them.

As mentioned, the results are presented in terms of number of students replying, in other words, in terms of the raw frequencies. It is not possible to make good sense of such a table. The idea of the *proportion* of students giving the various replies is the key, leaving the question of which proportion will be most useful. That line of reasoning leads easily to percentage, as a more convenient number (and to discussion of rounding and rounding error). Table 2 shows the results converted to percentages. We have already cut the story short here by pointing out the interesting feature of this table--the remarkable reversal of percentages in columns

one and two in the Grade 9 row, and the return to the overall pattern in Grade 10. Whereas roughly three-quarters of the students in other grades said they would finish Grade 13, only one quarter said that at the end of Grade 9. The results were carefully checked for errors and none were found.[6]

Students in Grades 7 to 10 would likely have many explanations for the result, but they should also try other ways of calculating the percentages--by columns, for example, and for each cell as a percentage of the grand total. Neither of these give a satisfactory (meaningful) result, but demonstrating this will give a lot of purposeful practice. If the question is, "Does the grade a student is in tell us what sort of future plans they will have?", the percentages must be calculated by grade for each category of plans, that is, the percentages must sum to 100 for each grade.

We are back to predicting the future, since another way to put the question would be, "Can we predict students plans from the grade they are in?" Explaining why this is so gets right to the heart of the meaning we can make of percentages, so most classes should include it. Here is the outline.

> Stating the question in reverse order is not realistic (plans predicting grade), since students can make their own plans but have little control over grade. The *direction* of prediction dictates which percentages should be calculated. To predict *plans* from *grade*, we have to compare Grade 7 plans with Grade 8 plans, but the different numbers of student replies in those grades make the frequencies non-comparable. Expressing each number in a row as a percentage of row (grade) total gives us the right numbers to compare. Some people call this *standardizing by grade*, since we express the numbers for each grade in a *standard* form. If we predict by grade, we have to standardize by grade.

Teachers who have had an opportunity to study probability can introduce it inductively in the context of such tables. Probability is not included in most Grade 8 curriculums, but the calculations are elementary

and the concepts intuitive *if kept within a restricted, meaningful context.* Considering the group of 3506 as a whole and considering only grade, the likelihood (odds, probability) of picking at random and getting a Grade 7 student is 934/3506, or 0.27, or 27 times in 100. The probability of picking a Grade 9 student, however, is only 0.20. The probability that a student will have said she or he planned to finish Grade 13 is 2225/3506, or 0.63, while the probability for finishing Grade 12 but not 13 is only 0.34. Motivate these seemingly useless observations by promising that they will give new insights into prediction. (If students notice that these things you call probabilities sum to one for plans and separately for grade, then so much the better. Do not point it out.)

Ask the students as homework to try to think of ways these probabilities can be used in prediction. Say that it might help to consider what it means for a student to be in one of the cells of the table--in the top left-hand corner, for example. They may come up with nothing, but remember that learning problem formulation and clarification is also a goal of schooling. Someone may surprise you. By whatever route, get to the point that solving hard problems is often a matter of solving a simple version first--take the special case where you *cannot* predict plans from grade and see if you can do something with that. Not being able to predict is simpler, because plans do not depend on grade and the two can be treated independently. Now tell them that in this special case, they can calculate the probability of the two outcomes at once (for example, picking a Grade 7 student who also plans to finish Grade 13) by multiplying the separate probabilities, something they can show in general later in their career if need be.

A very small amount of calculation will show that this special case does not apply to Table 1. Take that odd cell in the Grade 9 row, for

example, the number planning to complete Grade 13 (178 students). If this were a special case, the probability of these two together is the product of their probabilities, (0.63)(0.20) = 0.13. We should find 13 percent of the students in that cell, whereas we only find 5 percent. There are discrepancies in just about every cell, telling us (again) that there is a link between grade and plans--that they are not independent. Working with the probabilities, however, gives us a systematic, objective way to show that the percentages depart from a simple, regular pattern. Keen students can be put on to Chi-Square statistics and hypothesis testing.

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Notes

[1]Crisis in science: (Duschl, 1985, Science Council, 1984); doldrums in math: cite[cra70sch,sir83wha]; international studies: (McLean, Wolfe, & Wahlstrom, 1987, McKnight et al., 1987); 'national' studies: (McLean, 1982, Connelly, Crocker, & Kass, 1985)

[2]On nine ratio and proportion items in the international survey, an average of 42 per cent of Ontario students answered correctly at the beginning of the year and 50 per cent at the end. On eight items covering percent, the percentages correct were 36 and 49. A province-wide survey in 1981 revealed only a little more growth through Grade 10.

[3]See, for example, (Gorman, 1986).

[4]The ideas on which this recognition was based were formulated in Europe more than 50 years ago, but even though he elements were set out in English before World War II, it was some time before they affected teaching in North America (Rosenblatt, 1938)

[5]Some writers would limit the term *problem solving*, e.g. "A problem that holds no surprises in store and that can be solved comfortably by routine or familiar procedures ... is an exercise." (Schoenfeld, 1983). These authors might refer to many of the problems proposed here as *exercises*. We will continue to refer to them as *problem sets* and to the process of arriving at solutions as *problem solving*, inviting the readers to think of them as exercises if they wish.

[6]The survey and a discussion of it are reported in McLean, Les (1982) *Willing but not Enthusiastic*. Available from the Ontario Government and OISE bookstores.

The Inductive Curriculum - School Report

At the end of more than a year of developing the 'Problem Sets' which were to be used to investigate the theory, it was decided that the time had arrived to pilot them in the schools. The following is an account of the experiences of the project team from initial encounters with board personnel to the use and presentation of the materials in actual classrooms.

Contacts with teachers were made through administrators of boards of education and through personal contacts with other teachers in the system. As required, permission was obtained from the necessary officials in order to take the project into the schools.

The project staff discussed the project materials with teachers from five boards of education: Durham, Peel, Metropolitan Separate School Board (Scarborough), Toronto and York Region. Teachers of grades seven and/or grade eight were the target. In two cases the teachers were mathematics specialists, all the rest were generalists. One teacher was at an inner city Toronto school. The teachers from York Region were both teaching enrichment classes. All the teachers had an initial interview of approximately two hours with the principal investigator and the research officer. Those who were interested in working with the project materials had not only extra materials with which to work but many more hours of exposure to the research team. The research officer went out to the schools on a number of occasions to observe and discuss the materials with the teachers. The principal investigator spent an hour actually teaching with the materials in the teachers' own classrooms in order to demonstrate how the materials should be used.

All but two of the teachers were in suburban locations. Four of the teachers spent more than two months each working with the materials. Of those teachers three were female and one was male. The teachers all seemed genuinely interested in the materials and were pleased with the responses of the majority of their students. One of the

teachers quoted a student as asking "When are we going to do math? This isn't math. This is fun." Another commented that a child who had been very unhappy and poor at doing math was taking an active part in her group. Another teacher described the positive responses he had received from parents at Parent/Teacher Interviews when he showed them the material and talked about it. The 'Real' aspect of the problems impressed the parents.

The prime motivation for working in the schools was to develop and refine the Inductive Curriculum: Mathematics in Context for the Middle School. An adjunct feature of the work was the development of group skills for working on the problem sets. In addition, the concept of folders or portfolios following the model of the English Writing Folders was used. In some of the classes groups had not been used before. One class in particular was normally highly-structured/teacher centred. A measure of how structured may be seen in the students' move to form groups. When they were told to move to their groups, they took up the seat they had been sitting on and moved with it to where their particular group was located rather than just moving and taking over any seat that happened to be available in the area. The teacher was surprised that the students were able to work together and based on the experience with the project materials intended to try groups in other subject areas. Each of the teachers was pleased to see that their less gifted students seemed to be taking a more active part in the math class. One girl who had shied away from math was actively involved in the problem solving of her group and expressed her pleasure with the group work both to her parents (who told the teacher) and to the teacher.

One of the surprising features of the study was the realization of how specific the directions to teachers and students had to be. What was implicit and apparently obvious to the research team did not appear so to the teachers or students involved. For example, it was assumed that the students would make notes from their discussions and those notes would be included in their portfolios so that some of their thinking could be followed. Unfortunately that was not the case. Only when they were explicitly told to

do something was there any evidence in the portfolio (tables and tests similar to those generated by textbook work). The teachers, too, needed explicit directions. When told to go around to the groups to encourage the work being done without leading the students, they did just that and didn't bother to interfere when students were interpreting something in a faulty way. The teachers were encouraged to go around to get the feel of the groups and what problems were turning up in all of the groups and would thus warrant a whole class discussion. They were also supposed to encourage the groups to work together in solving the problems. It was hoped that when they saw a group going off in an unfruitful direction, they would guide them towards a better resolution.

The students were most active when they were working on a problem with which they could identify. Every class conducted its own personal survey with each group making up a table to represent their results. In most cases these tables were simple one-way tables rather than the two-way tables we had hoped they would use. In some cases bar graphs were made representing the data they had collected on their own. In one case a bar graph had been made which because of its format created difficulties for the group involved. One of the group members was asked to explain the bar graphs to the research officer. He had been chosen by the teacher to do the explanation because he did not understand. One of the reasons he did not understand was because the data was displayed in a way that made it difficult to make the comparisons. The teacher had not intervened to lead the students into a modification of their presentation so that they would be better able to understand their results. Perhaps,the teacher did not understand the difficulty created by the group's display of the data (unrelated data in adjacent bars and related data remote).

The first of the 'Problem Sets', "Making Sense of Opinion Polls", was taught exclusively by the teachers to their own class. None of the teachers found that there was enough material in the problem set to take the four weeks that had been suggested for the exercise. It was necessary to develop more materials as the work in the schools progressed and more illustrations of the concepts were necessary. Additional polling

problems were developed using current events, future forecasts from a popular magazine and information on attitudes towards examinations from *The Times Educational Supplement*. The teachers took an active part and even provided some of the materials themselves including information from a daily newspaper, scores from hockey games and results from polling the school on a topical concern. In each case, the teacher reported increased interest from students when one of their own polls was the subject for discussion.

The Principal Investigator introduced the second 'Problem Set', "The Community Centre Gets a Swimming Pool" to three of the classes involved in the project. In two of the classes there were six groups of more than five students each. In each of those classes at least one of the groups was completely uncooperative taking no interest at all in what was going on in the class. They did not read the material carefully or attend to the description being given. Attempts were made to get them involved but without success. The Teachers confirmed that these students were generally difficult to motivate and responded only to simple, specific tasks and direct supervision. The technique and materials, like any other teaching technique, is not suitable for everybody. The teachers were pleased at the progress made by the rest of the class. The third class was much smaller and consisted of approximately twenty. This class had been together as a French Immersion Class (half day English/half day French) for a few years. They knew each other and worked well in groups supporting and cooperating with each other. They all appeared to take an active part in working on or listening to information on the problem set.

Evaluation was a problem. One of the chief concerns expressed by the teachers was "How do we test the students so we can get a measure of how much they know?" A couple of the teachers used exercises from the textbook that would normally be used in the classroom or one of the exta examples provided by the project team to test for knowledge of the concept. All looked for concrete examples of attainment. None of the teachers used the portfolios in the way suggested in the Teacher's Guide. There was no

discussion with the students to get their views of how well they had done on something and whether each member of a group understood what his/her group was doing. The function of the cumulative folder seemed unknown to both teachers and students even though its role was clearly stated in the Teacher's Guide.

The teachers were given a questionnaire which asked them to comment on the materials and suggest changes, additions and subtractions, that might make the materials more meaningful and useful. They were also asked to describe how they used the material with which they were provided. The questionnaires completed by two of the teachers are included as an appendix to this report.

Each of the teachers involved in this project was enthusiastic about teaching mathematical concepts using contexts with which the students could identify. They agreed with the project team that more work needed to be done to make the students more comfortable working in groups and that they, too, needed to be more comfortable with groups for them to work well.

One of the teachers said he would use the materials again with another class and that with the experience he had working with the project team he was sure the programme would work better. Another said she found the material very interesting and good for some of the students but not suitable for students who needed to be taught in a highly structured way.

Questions about Making Sense of Opinion Polls

We really appreciate your willingness to use our materials in the classroom. It will be a great help in our work if you take the time to answer some or all of the following questions.

Please be critical. Help us to make the material as meaningful and helpful as possible. If you think it needs a major re-write, let us know.

1. How much use did you make of the Teacher's Version of *Making Sense of Opinion Polls* (Approximately how much time? Did you find it helpful? Any suggestions?)

2. How much use did you make of the *Teacher's Guide: The Inductive Curriculum -- A General Introduction to the Methodology* (Approximately how much time? Did you find it helpful? Any suggestions?)

3. Are there any changes you would recommend for the *Students' Version*? Please explain.

4. Were you able to use the additional materials (for example, as homework, additional practice, etc)?

   - Meech Lake

   - Future Prospects

   - Views on Examinations

   - Spaghetti Problem(Even though this problem was not designed by us, we would like to know what your reactions and those of your students were to the problem)

5. How did you evaluate student performance?

6. Other comments, suggestions?

Sample reply from teacher

Questions about Making Sense of Opinion Polls

We really appreciate your willingness to use our materials in the classroom. It will be a great help in our work if you take the time to answer some or all of the following questions.

Please be critical. Help us to make the material as meaningful and helpful as possible. If you think it needs a major re-write, let us know.

1. How much use did you make of the Teacher's Version of *Making Sense of Opinion Polls* (Approximately how much time? Did you find it helpful? Any suggestions?)
   - followed Guide for Day 1 only
   - rest of information was interesting, but did not all apply to my Grade 7 class - eg pie charts

2. How much use did you make of the *Teacher's Guide: The Inductive Curriculum -- A General Introduction to the Methodology* (Approximately how much time? Did you find it helpful? Any suggestions?)
   - I read it prior to beginning unit with class
   - I followed the instruction in Getting Started
   - proposed time line was too long

3. Are there any changes you would recommend for the *Students' Version*? Please explain.

- would not give totals in Table 1 - allow students to work out for themselves
- Problem 2 was an excellent learning experience - students learned on their own that raw data was meaningless and couldn't be compared with other classes
- Problem 4 - little value because percentages already worked out

4. Were you able to use the additional materials (for example, as homework, additional practice, etc)?

- Meech Lake – no
- Future Prospects – no
- Views on Examinations – no

time restraints
- lessons needed to teach mechanics of %, conversion to fractions, decimals & vice versa

- Spaghetti Problem(Even though this problem was not designed by us, we would like to know what your reactions and those of your students were to the problem)

- those who carefully read the article and knew what the total point were, could easily work out the percentages

5. How did you evaluate student performance?

- each student responsible for conducting a survey of his own (one example - colour of Smarties in a 250g box), including a tally sheet, a graph (individual choice) and percentage totals

6. Other comments, suggestions?

- less time needed for material given
- more samples of polls (Meech Lake was the only poll I had at the time and the subject matter was not of interest to Grade 7 student) - I found the spaghetti poll, and the article on 13-year-olds' math & science skills to be of more interest to the age group

Questions about Making Sense of Opinion Polls

We really appreciate your willingness to use our materials in the classroom. It will be a great help in our work if you take the time to answer some or all of the following questions.

Please be critical. Help us to make the material as meaningful and helpful as possible. If you think it needs a major re-write, let us know.

1. How much use did you make of the Teacher's Version of *Making Sense of Opinion Polls* (Approximately how much time? Did you find it helpful? Any suggestions?)

I used it more as a reference from time to time so it's difficult to say how many minutes/hours. The introductory strategies were workable/appropriate. For the "Middle Days", I found it awkward at times to work in other related concepts e.g. ratios/fractions due to some external problems involving students behaviour. Obviously, that is not the fault of your program. One suggestion might be to give a specific sample problem based on the data e.g. how fractions/decimals/percents should be related. I did not cover ratio in depth at all and will have to correct that. The graph activity was extremely useful and enjoyable (for the whole school) because they had to think of the question, carry out the survey, tabulate results, etc. In retrospect, I feel I should have taken more time out for single group "lessons" rather than making them work it out themselves.

2. How much use did you make of the *Teacher's Guide: The Inductive Curriculum -- A General Introduction to the Methodology* (Approximately how much time? Did you find it helpful? Any suggestions?)

This document certainly made clear the rationale behind this approach; I was not able to implement all of the suggestions/strategies but I saw their validity. I especially liked the idea of portfolios and so did the students. Even those students who did not fare well were able to see the practicality of the problems, especially when I supplemented those provided in the problem sets with polls taken from the daily paper on subjects such as violence in hockey and Canadians' feelings on racism. Parents with whom I discussed it were impressed with the range of topics being covered in one activity as opposed to just working on percent. Even the core of people who aren't keen on the use of calculators saw that they were being used as a labour/time-saving device, not as a substitute for learning the concept. As far as the Evaluation suggestions go, I did not implement them as thoroughly as I should have, due mainly to time constraints - I had to get reports to the office - but I liked the idea suggested in the guide re a cooperative determination of criteria. Next time I would certainly try to incorporate this particular approach.

3. Are there any changes you would recommend for the *Students' Version*? Please explain.

I liked the layout of the Student Version overall. My main concern, based on the experience of my class, is that the sections marked "To Think About" and "To Discuss" perhaps should be made mandatory for writing out, just as the "To Do" sections are. The reason in my experience, is that when I assign "reading" in other subjects, they often treat it very casually since they don't have to show it like regular homework exercises. As a result, I will occasionally give a short "snapper" test based on such reading assignments.

4. Were you able to use the additional materials (for example, as homework, additional practice, etc)?

- Meech Lake This one was used last week (a 3-day week) more as a "filler". The students found it somewhat anti-climactic, I suppose, but they really did not "turn on" to the topic either. I made them do it and at least they saw that many Canadians shared their indifference. Nevertheless, with some lessons on the implications of some of the provisions of the accord, such as taxation and provincial powers, they showed more concern.
- Future Prospects I used this one for a major test and complemented it with a similar survey of the Grades 7/8 in our school. This table was good for calculations, of course, but I found it useful for developing skills of interpretation also. They were able to see how their youth affected their responses to the same questions answered by adults.
- Views on Examinations Although I planned to use this one originally, I discovered several in the newspaper and simply never worked it in. In studying it, I would like to work on it in connection with some guidance lessons later in the year on the topic of exams (they will have to write them next year).
- Spaghetti Problem(Even though this problem was not designed by us, we would like to know what your reactions and those of your students were to the problem)

I found that the students handled this one well after being exposed to the earlier problem sets your office provided. I definitely should not have included the cost-unit price exercise since it was beyond the scope of the topic. My only defence, I guess, is that I wanted at that point in time to make the groups cooperate in the solution of a difficult problem. Incidentally, I took up a couple of them, then let it "die".

5. How did you evaluate student performance?

Given more time and better organization on my part, I would have at least tried to implement all the suggestions given in the guide. In practice, I essentially used short daily tests from time to time, collection of portfolios (especially when they did not do well or I sensed that they were just copying classmates' answers), and longer tests. With a better appreciation this time, I intend to incorporate more variety into the evaluation process.

6. Other comments, suggestions? I guess my main concern - as it always will be for teachers - is how to "reach" those who have a block in this subject or don't care enough to persevere through difficulties. A few still will not cooperate with their classmates - not in a sense of getting along but rather in the literal sense of the word. At times I am torn between pulling them out of the program altogether and letting them drift. Perhaps new companions will help. There are not many but it still irritates me to see how they are cutting themselves off from a valuable aid.

List of Problems to Date Developed for Mathematics

The following is a list of problem sets developed for the Inductive Curriculum as of May 15, 1988. The name of the set is given, plus a description of the guideline topics covered and the status of the set.

1. *Making Sense from Opinion Polls.* Sample surveys are presented as ways of predicting what people will do--what they will buy, how they will vote and what they will do in the future. The first problem in this set uses results from a survey of students in which they were asked whether they intended to complete Grade 13, stop at Grade 12 or leave before completing Grade 12. The teacher's version contains a guide to the use of polls published in magazines and newspapers. The problem set requires the students to use ratio and proportion, organize and represent data, and use decimals and percent to solve the problems. The problems also provide material for the study of probability, an optional topic in Grade 8. Both the students' and the teacher's versions are complete.

2. *The Community Centre Gets a Swimming Pool.* A prominent citizen offers to donate a pool to the community centre. The task set for the students is to determine whether the offer can be accepted. Will it fit? How much would it cost the community to put the pool in place? The problems within the set involve the use of calculators, whole numbers, decimals, factoring, measurement, the Pythagorean Theorem, basic notions in plane and simple three-dimensional geometry. Estimations, transformations (enlarging and reducing) and scale drawings are suggested as ways of resolving the problems. Both the students' and the teacher's versions are complete.

3. *Watching What the Bank is Charging You.* Simple banking transactions are reviewed in preparation for a study of the charges banks make for their services. The task set the students is to minimize the bank charges for several different mixes of banking services. It involves the use of calculators, per cent, decimals, tables, statistics, fractions and negative numbers. This problem set is in the conceptual stage.

4. *The High Rise Delivery System.* This problem set requires the use of positive and negative whole numbers. Graphs would be useful to describe the action taking place in the problem. It takes place in a high rise bulding where a courier has to deliver packages on a schedule that requires retracing steps many times. The courier files a report at the end of the day and is paid by distance (number of floors) travelled. The set is in its initial stage.

5. *Saving Jobs in the School Cafeteria.* Students learn that the cafeteria manager is going to lay off staff because of rising costs. They try to find other ways to save money and the jobs of the people they have come to know. The problems in the set require the use of percent, calculator skills, whole numbers, decimals and relationships. The students' version is complete.

6. *Locating a School in a New Community.* Measurement, geometry, estimation, transformations (enlargements and reductions), scale drawing, calculators, percent, organization and representation of data, use of a number line and integers are required for this problem set. It involves the

location of a school in a new subdivision. The students' version is complete.

7. *A Supermarket Display Contest.* Students enter a contest that requires them to design displays for a supermarket. Geometry (plane and three-dimensional), measurement and construction of tables are required. The students' version is complete.

8. *Solar Panels for Heating Water.* An antiquated heating system in the school does not provide enough hot water for showers when several classes have physical education on the same day. The school board is unable to provide a new heating system for several years. Students read that solar panels can usually provide supplemental hot water at low cost, even in winter, and they set out to convince the board that solar panels should be installed--at least as an interim measure. This problem set deals with scientific problem solving, technology, properties of matter, per cent, measurement, geometry as well as number and calculator skills. It is still in its initial stage.

A Curriculum for Cooperative Teaching and Learning

Short form used to introduce teachers to the curriculum

The inductive curriculum is an integrated approach to teaching and learning in the middle school. It has three major components (problem sets, cooperative group work and portfolio assessment), but these are not separable. All three operate interactively to stimulate and support learning.

Guidelines for the Teacher

1. Always focus on meaning--the meaning of words (sentences, paragraphs,...), the meaning of numbers, the meaning of graphs and charts.

2. Be a resource for groups of students working cooperatively.

3. Work from specific to general.

4. Base your evaluations directly on individual performances.

5. Ensure that students participate with you in the evaluation of their work.

Getting Started

1. Take in hand the Teacher's Guide and Students' Version of *Making Sense from Opinion Polls* when you have at least half an hour to read them.

2. Read quickly over the Students' Version, to the end of "Problem Four". Stop there, but keep it close by.

3. Read the Teacher's Guide (TG). When you come to "Day 1", ..., "Middle Days", ..., refer often to the first problem in the Students' Version, especially Table 1.

4. When you have read the Teacher's Guide once through, go back to the "Guidelines for the Teacher". Think how each one applies to this problem set.

5. Go over Day 1, ..., again if you need to refresh your memory.

6. Organize for work on *Making Sense from Opinion Polls.*
   a. Assign students to groups of 5 or 6, making each one reflect the range in the class as much as possible.

   b. Get portfolios for everyone, if they don't have them already.

7. Start the problem set when you are sure you have a full period--at least 40 minutes.
   a. Pass out Students' Version.
   b. Give them a few minutes to read the first two pages.
   c. Go through it with them. Try to ensure everyone understands the words and ideas, (*as applied to this problem*) -- this poll, the predictions one might make from this poll. Get them to picture the 264 Grade 8 students who said they would complete Grade 12 but not 13.

8. Continue discussion in whole class until everyone is satisfied. This might take a period or two for the first set.

9. Read out group members and reorganize the class.

10. Go over the 'Guidelines for Group Work' until everyone is satisfied.

11. Ask them to start work on the problems. Tell them (a) you will be around to see how they are doing but that they are to figure things out themselves as far as possible, (b) each student must keep a solution to each problem in their portfolios, because the groups will change for the next problem set, and (c) you will go over the marking after they have some work done.

12. Circulate. Be a resource.

13. Call them back when finished with Problem Four, or sooner if you see the need.

14. Assign individual homework and explain that this is for them and for you to see if they have everything straight.

15. Assign research and writing related to the work.

16. Take a period or two for reflection (see Teacher's Guide).

17. Go back to more polls or go on to another problem set or do something better you and the class have worked out.

Guidelines for Group Work

1. Work together to understand and solve the problems

2. Ensure that everyone participates actively

3. Listen carefully to each other and to try to incorporate everyone's ideas in the solutions

4. Be sure everyone understands what they put in their portfolios --how it was done, why it was done, and what it means

5. Make decisions by consensus, for example, adopt interim solutions, decide to work longer on some aspect or move on to something else.

How to Use Your Portfolio(s)

1. Start a new portfolio each time you start a new problem set (*Making Sense of Opinion Polls* is a problem set.) We call this the *active portfolio*.

2. Keep all your work related to the problem set in the active portfolio--the description handed out by the teacher, rough notes, interim solutions to problems, related research materials (if any) and final solutions to problems.

3. Be sure you have a copy of all solutions produced by your group. You may not be working in the same group on the next problem set, and you need to have a record of what you have accomplished. Remember, you must understand everything you keep in the portfolio and help others understand.

4. When the teacher and the class decide to stop work on a problem set, transfer your completed work to your *cumulative portfolio*. Discard working notes and interim work now incorporated in the final solutions. Your term and final marks will be based on work in this folder (so you see why you have to keep a copy of everything the group does, as well as saving your own homework). It might also be used to show parents what you and the class have accomplished. Marks will be based on the number of correct solutions to the problems assigned by the teacher and on ways you have added to these problems.

5. Review your cumulative portfolio with your teacher once or twice before term marks are due. Your teacher will help find the right time to do this. The purpose of this review is to give the teacher feedback and together to identify correctly completed work.

Teacher's Guide
The Inductive Curriculum--
A General Introduction to the Methodology

The inductive approach employs problem sets to present mathematics in a functional way, emphasizing the uses of mathematics in a meaningful context. Students who are presented meaningful problems are more motivated to solve the problems and they learn concepts and skills in the process. Of course, problems meaningful *to them* are needed. The objective is for all students to master the key concepts and skills (as outlined in the Guidelines) by the end of the year.

The Inductive Curriculum is a framework for *doing* elementary mathematics; there is no attempt to teach problem solving in the abstract. Working through the problem sets takes the students through problem-solving steps that are then identified in the period of reflection at the end of each set. Students see a purpose for the skills and concepts, and the link to their own experience helps them to remember what they have done and to transfer to new problems. The emphasis is on cooperation in whole class and small groups because, research has shown that cooperative work results in more and better learning than working individually or in competition.

The Learning Tasks: Problem Sets

Problem Sets - Criteria

Each problem set is focussed on a guideline topic such as measurement or percent, but a meaningful set necessarily brings in a variety of skills and concepts.[1] To be included in the inductive curriculum, problem sets have to meet these criteria:

1. Students recognize and can identify with the context (setting) of the problems. (Some sets may therefore be inappropriate in some settings.)
2. The mathematics needed to solve the problems is useful and central to the solution of the problems.

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[1]This general introduction will be more meaningful if an actual problem set is at hand to serve as an illustration of the points

3. A satisfying solution is accessible reasonably quickly for all students, but there are easy and natural extensions that challenge the more able students.

4. Other versions of the problems can be easily generated for practice and evaluation without boring repetition.

Problem Sets - Format

Each problem set is provided in two versions:

1. The students' version, including a preamble that sets the context for the problems, and

2. The teacher's version, containing all, or almost all, of the following:

   a. a brief narrative description of the problem set,

   b. the skills and concepts involved in the minimal set,

   c. suggested timing,

   d. specific presentation tactics,

   e. solutions to all the major parts of the set,

   f. extensions that may be investigated, and

   g. suggestions for evaluation.

Problem Sets - General Guidelines for Choice and Use

The problem *sets* may be taken in any order. Each set takes about four weeks to complete, assuming 40-minute periods five days a week, with time out for holidays, assemblies and the like. Teachers meeting the sets for the first time should read the narrative description of each one and choose seven or eight sets for a school year, according to the amount of the curriculum guideline intended to be covered.

Problems should be discussed with the class as a whole before the students begin to work on the tasks. Routinely draw diagrams to help the students to understand the problem statements and imbue them with the value of a diagrammatic representation of something they are having trouble understanding. Start with any one of the problems and progress through to the other problems. The teacher should avoid making

generalizations while working on the problems. Ask successful students to describe the strategies they used. Encourage students to share their solutions so that they become the ones doing the generalizing.

At the end of each problem set (see 'Reflection') have the class reflect back on what they have been doing. When the teacher and class decide that enough time has been given to a problem set, one or two days should be spent by the class reflecting on the work, thinking about ways the various problems were solved and arriving at some generalizations. If no generalizations appear after a reasonable time, the teacher should spend more time on the problem set. This does not mean going back and doing the whole thing over, of course. Instead, start with the introduction to the problem set and sample sections throughout, finishing with another period of reflection and discussion as a class. One of the goals here is to get as many students as possible actively involved in the discussion.

Problem Sets - Specific Suggestions

1. One or more periods at the beginning should be used to discuss the problem set and be sure students know about the setting and the vocabulary. It usually works best to assign the problems as reading homework, with the request to come to class with questions ready (perhaps written). If this is the first time through a problem set, outline the approach: discussion, small group work, whole class, new small groups, individual assignments, evaluation methods. Stress that *they* are to solve the problems, working together at first, and that they should begin by asking all questions necessary to understand the problem.

2. When it seems everyone understands the setting and the task, assign students to groups of four or five or six (depending on the size of class and space available), trying to make each group reflect the full ability range in the class. You make up the groups in advance, using what you know of the students. If they are new to you, do it at random and be ready to reform groups early in the work. Tell them the groups are to work independently, but that they will share their approaches and results often. Ask each group to name a reporter.

3. After one or two or three periods of work in groups, in which the teacher joins from time to time, bring them back together so the reporters can describe progress and problems. If there are problems with prerequisite skills and concepts, send them back to work on those. Teach a whole class lesson *only* when it is your opinion that everyone needs it. Use your judgment to decide how many times to do this (small groups to class to small

groups and back to class). Some problems sets usefully take three or four cycles.

4. When your judgment tells you it is time to stop, take 1 - 2 periods for the students to reflect on the problem and notice techniques and approaches that worked across problems in the set. (See Reflection.) Take more time if it is going well, as this process of reflection is very important to consolidation and transfer.

5. If the techniques and approaches were not understood by the majority of the students, work back into the problem set. Use the students who showed competence solving the problems to help the others.

6. Go on to a new set. Encourage students to comment on links between the sets. Treat each set as a new challenge.

Evaluation

A systematic cumulative record of performance should be maintained by each student. It will take the form of a portfolio much like the *Writing Folder* used in Language Arts. Each student should maintain two portfolios: one with current work on a problem set and perhaps some leftover work from the previous problem set, the other with finished work (solutions to problem sets on which the student is no longer working). The active (current) portfolio contains work-in-progress; the cumulative portfolio contains completed and evaluated work. Exactly what goes in the cumulative portfolio is decided jointly by teacher and student, with the teacher setting some minimum requirements. The teacher also describes to the whole class what constitutes an average and a superior portfolio.

More on Assessment, Evaluation and Grading in the Inductive Curriculum

The overall goal of the Inductive Curriculum has always been for assessment, evaluation and grading to be an inseparable part of teaching and learning. It must not be seen as something *extra* teachers have to do, something that takes time away from learning. If teachers see it in such a way, then we have not got it right, not succeeded in our primary objective.

Assessment: The development of awareness, through diagnosis, of a student's

progress in order to aid learning.

Evaluation: Determination of the value of progress made to date in order to aid teachers, students, parents and officials in decision making.

Grading: Preparation by teachers of highly condensed summaries of evaluations in order to communicate the evaluations to students, parents and officials.

Educational Accountability: Demonstration by students, teachers, officials and Trustees that the progress for which each is responsible is valuable and sufficient.

The portfolios kept by each student are used as the focus for assessment, evaluation and grading. An approach is outlined here by which assessment, evaluation and grading are done with problem sets and individual assignments. There should be no need for tests, either to motivate or to evaluate the students. Such an approach is consistent with the theories on which the Inductive Curriculum is based, theories that imply (1) a primary focus on meaningful problems, hence on realistic settings, (2) building up understanding by doing, arriving at general rules and other abstractions by reflection on experiences, (3) evaluation based on cumulative records of student performance, and (4) primary reliance on cooperative learning.

Portfolios help students organize their work, provide a cumulative record and serve as the explanation for parents of the condensed summaries issued on report cards. Each student keeps two portfolios going at once--the active and the cumulative portfolio. The active one contains all material for the problem set on which the student is currently working, and, as its name suggests, the cumulative portfolio contains completed work selected as the ongoing record of achievement. The active portfolios, and to some extent the cumulative, are key resources for assessment. The cumulative is used for evaluation and grading. Summaries derived from the cumulative portfolios can provide convincing evidence for accountability, but for the moment we concentrate on assessment, evaluation and grading.

Teachers will naturally review students' active portfolios as they circulate around

the groups and respond to questions. Assessment will happen without the need for organization in many cases. The challenge will be to ensure that no student goes very long without a review, and this will take some organization. Fairness requires that everyone's work be examined at regular intervals--once per week, for example. Teachers might simply write the date inside the front cover when a review takes place, and ask periodically for all students with a date more than a week old to come to see them. Interim visits for questions need not be recorded, of course, since the object is just to keep anyone from going along too far in a wrong or unproductive direction. Many teachers will make assignments and create opportunities that make writing down dates unnecessary.

As the class comes to the end of work on a problem set, items will be transferred to the cumulative portfolio, and these should be assigned to rough evaluation categories, for example:

1. Incomplete or unsatisfactory or both (extreme case: no work at all).
2. Incomplete, but satisfactory as far as it goes. Shows understanding of the problems and at least part of the solutions.
3. Complete, satisfactory understanding of problems and solutions.
4. Complete and satisfactory, with added material that extends understanding of the problems beyond the questions posed explicitly in the set.

As a marking time approaches (report cards, ...), the teacher and class establish how much work is to be considered in establishing marks at that time. Each student reviews her or his cumulative portfolio and prepares a summary report for the teacher. The teacher reviews the reports, and perhaps some portfolios, and assigns marks according to an agreed-upon scheme. The evaluation can be based on the categories, for example,

A. All work is category 3 or better (complete and satisfactory).

B. No 1's, and at least one piece of work is in category 3.

C. Median 2 or better (half the work is 2 or better).

D. Median less than 2 (less than half is complete).

E. All 1's (no complete work).

Reflection

Ask students to look back over what they have done and develop hypotheses about the work. Help them to do this if necessary. For example, have the class work through the solution(s) to a problem with you serving as moderator or orchestrator of ideas. A good analogy might be that of a sports referee, who starts the game and keeps it going according to the rules. The players (students) have to make the moves drawing on their preparation and previous experiences. The problem with this analogy is that the teacher must be both referee and coach.

Check the answers against the problem statements. Check the arguments that led up to the answer, look for alternative solutions, try the problem in a different context, use a similar method of resolution on another problem set.

If the students are not able to take an active part in the reflection, then it will be necessary to take them back through the problem set, not in the same depth with which it was handled originally but spotting through it to try to find where they got lost.

The 'reflection' should involve the teacher leading the students back through the problems to recapitulate what was done until they are able by themselves to follow a scheme of recapitulation.

Guidelines for Group Work

Here are 5 guidelines to give to the students:

- Work together, first to understand and then to solve the problems
- Ensure that everyone participates actively
- Listen carefully to each other and try to incorporate everyone's ideas into the solutions
- Be sure everyone understands the work they put in their portfolios--how it was done, why it was done and what it means

- Make decisions by consensus, for example deciding when to adopt interim solutions, to work longer on some aspect or to move on to something else

Making Sense from Opinion Polls

Form "A" of problem set

Major Topics:
- Proportion
- Percent
- Ratio
- Estimating
- Using a Calculator
- Probability and Statistics

Other Topics:
- Using a Table/Chart
- Polling
- Tabulating
- Problem Solving
  - constructing a table
  - estimating
  - guessing and checking; improving the guess
  - accounting for all possibilities
  - checking for hidden assumptions
  - making an assumption and drawing a conclusion

Integration with Other Subject Areas:

- Current events
- Politics
- Economics

Introduction to the Problem Set

Hardly a day passes without reports of some new survey of public opinion--"Who would make the best Prime Minister?", "If an election were held tomorrow, which party would you support?", "Should the legal age for drinking be raised?". One or two thousand people across Canada or across a province are carefully chosen and asked to answer the questions. The results are then expressed in percentages, such as, "The Conservatives have climbed three points since the last poll, to the highest point since the beginning of the year and the NDP dropped slightly. Thirty-four percent of Canadians would vote Conservative and 25 percent NDP, with the Liberals remaining constant at 41 percent.

These polls, and surveys, which the students can conduct themselves, provide interesting ways to learn what percentages are and how to calculate them. Surprising challenges, and surprising results, are often encountered when we try to find out whether women answer differently from men, older people differently from younger and the like. Ratio, proportion and percent are covered with plenty of practice in estimating and using a calculator. Extensions to probability and statistics will challenge the best students right through high school and beyond, but there are many interesting results to be found by elementary means.

Making Sense from Opinion Polls

Teacher's guide Day 1

Teacher discusses the problem with the class as a group before students begin to work on the tasks. Do this by presenting on paper and aloud the 'Student's Version' of the problem set.

Vocabulary:	polling	polls
	surveys	predict
	tabulate	

One or more periods at the beginning should be used to discuss the problem set and be sure students know about the setting and the vocabulary. Try assigning the problems as reading homework first, with the request to come to class with questions for clarification ready (perhaps written). If this is the first time through a problem set, outline the approach: discussion, small group work, whole class, new small groups, individual assignments, evaluation methods. Stress that *they* are to solve the problems, working together at first, and that they should begin by asking all questions necessary to understand the problem.

When it seems everyone understands the setting and the task, assign students to groups of four or five or six (depending on the size of class and space available), trying to make each group reflect the full ability range in the class. You make up the groups in advance, using what you know of the students. If they are new to you, do it at random and be ready to reform groups early in the work. Tell them the groups are to work independently, but that they will share their approaches and results often. Ask each group to name a reporter and change the reporter each time so that each member of the group gets a chance to be the reporter.

Teacher's guide Middle Days

After one or two or three periods of work in small groups which the teacher monitors by moving from group to group, joins from time to time, bring them back together so the reporters can describe progress and problems. If there are difficulties due to prerequisite skills and concepts, send them back to work on those. Teach a whole class lesson only when it is your opinion that everyone needs it. Use your judgement to decide how many times to do this (small groups to class to small groups and back to class). Some problem sets may require three or four cycles.

Whole Class Lesson Suggestions

The following are suggested (only) objectives that may be used as didactic teaching periods or parts of periods. They may involve the whole class or simply the students who require it. After some encouragement, it can be left up to the students themselves to decide whether or not they 'require' the lesson. For this particular problem set, most new ideas will involve ratio and percent. Other topics may call for review lessons.

1. Understand the concept of ratio; determine ratios from given facts; express ratios as fractions.

2. Understand the concept of percent; determine percents from given facts.

3. Express fractions as percents; express percents as fractions.

4. Find a percent of a number using decimals.

5. Understand the relationships between fractions, decimals, and percents.

6. Explain 1-way, 2-way tables.

7. Discuss various graphic presentations possible.
   e.g. pie charts, bar graphs, line graphs, etc.

Mastery of the calculations, understanding and use of percentages and proportions are the primary objectives of this problem set. Discussion of random sampling is probably unavoidable, at least at the intuitive level--the idea of a *representative* sample. It is suggested that students carry out their own survey in order to give them a better understanding of how such numbers are obtained, and this leads to questions about the comparability of samples. It is a golden opportunity to discuss the greater uncertainties associated with small samples, especially non-random ones. Analysis and discussion of a current or recent poll (from newspapers, magazines, ...) extends the set and provides reverse practice (if 1500 people were surveyed and 28 percent agreed, how many people is that?). Published surveys also bring in the concept of sampling error, such as, "The results will be accurate within four points, 95 percent of the time". This opens the way to discussion of probability if it suits class and teacher, but stick with percentages until everyone is comfortable with them.

As mentioned, the results are presented in terms of number of students replying, in other words, in terms of the raw frequencies. It is not possible to make good sense of such a table. The idea of the *proportion* of students giving the various replies is the key, leaving the question of which proportion will be most useful. That line of reasoning leads easily to percentage, as a more convenient number (and to discussion of rounding and rounding error). Table 2 in the Student's Guide shows the results converted to percentages. We have already cut the story short here by pointing out the interesting feature of this table--the remarkable reversal of percentages in columns one and two in the Grade 9 row, and the return to the overall pattern in Grade 10. Whereas roughly three-quarters of the students in other grades said they would finish Grade 13, only one quarter said that at the end of Grade 9. The results were carefully checked for errors and none were found.

Students in Grades 7 to 10 would likely have many explanations for the result, but they should also try other ways of calculating the percentages--by columns, for example, and for each cell as a percentage of the grand total. Neither of these gives a satisfactory (meaningful) result, but demonstrating this will give a lot of purposeful practice. If the question is, "Does the grade a student is in tell us what sort of future plans they will have?", the percentages must be calculated by grade for each category of plans, that is, the percentages must sum to 100 for each grade.

We are back to predicting the future, since another way to put the question would be, "Can we predict students plans from the grade they are in?" Explaining why this is so gets right to the heart of the meaning we can make of percentages, so most classes should include it. Here is the outline.

Stating the question in reverse order is not realistic (plans predicting grade), since students can make their own plans but have little control over grade. The *direction* of prediction dictates which percentages should be calculated. To predict *plans* from *grade*, we have to compare Grade 7 plans with Grade 8 plans, but the different numbers of student replies in those grades make the frequencies non-comparable. Expressing each number in a row as a percentage of row (grade) total gives us the right numbers to compare. Some people call this *standardizing by grade*, since we express the numbers for each grade in a *standard* form. If we predict by grade, we have to standardize by grade.

Teachers who have had an opportunity to study probability can introduce it inductively in the context of such tables. Probability is not included in most Grade 8 curriculums, but the calculations are elementary and the concepts intuitive *if kept within a restricted, meaningful context.* Considering the group of 3516 as a whole and considering only grade, the likelihood (odds, probability) of picking at random and getting a Grade 7 student is 944/3516, or 0.27, or 27 times in 100. The probability of picking a Grade 9 student, however, is only 0.20. The probability that a student will have said she or he planned to finish Grade 13 is 2225/3516, or 0.63, while the probability for finishing Grade 12 but not 13 is only 0.34. Motivate these seemingly useless observations by promising that they will give new insights into prediction. (If students notice that these things you call probabilities sum to one for plans and separately for grade, then so much the better. Do not point it out.)

Ask the students as homework to try to think of ways these probabilities can be used in prediction. Say that it might help to consider what it means for a student to be in one of the cells of the table--in the top left-hand corner, for example. They may come up with nothing, but remember that learning problem formulation and clarification is also a goal of schooling. Someone may surprise you. By whatever route, get to the point that solving hard problems is often a matter of solving a simple version first--take the special case where you *cannot* predict plans from grade and see if you can do something with that. Not being able to predict is simpler, because plans do not depend on grade and the two can be treated independently. Now tell them that in this special case, they can calculate the probability of the two outcomes at once (for example, picking a Grade 7 student who also plans to finish Grade 13) by multiplying the separate probabilities, something which may be useful later in their career.

A very small amount of calculation will show that this special case does not apply to Table 1. Take that odd cell in the Grade 9 row, for example, the number planning to complete Grade 13 (178 students). If this were a special case, the probability of these two together is the product of their probabilities, (0.63)(0.20) = 0.13. We should find 13 percent of the students in that cell, whereas we only find 5 percent. There are discrepancies in just about every cell, telling us (again) that there is a link between grade and plans--that they are not independent. Working with the probabilities, however, gives us a systematic, objective way to show that the percentages depart from a simple, regular pattern. Keen students can be put on to Chi-Square statistics and hypothesis testing.

Teacher's guide Reflection Days

The last activity when working on any problem set is the time for reflecting on the process and the outcomes. When your judgement tells you that it is time to stop, take 1-2 periods for the students to reflect on the problem and notice techniques and approaches that worked across problems in the set. Take more time if it is going well. The goal is to consolidate what has been learned and to generalize from the experience--this is the time to talk about rules and principles.

For example, in *Making Sense from Opinion Polls*, percentages in a two-way table must often be calculated in one particular way (either by rows or by columns) or they don't make sense. Is there any way to figure this out in advance? The answer is yes, of course, and the key is to identify whether you are going to consider one of the variables as the cause and the other the effect. In the first example, it made sense to consider "Grade" as the cause and "Plans" as the effect, since grade in school is a rough measure of age. Plans change (are 'caused') by grade and age, but age cannot be changed by plans. The percentages have to total 100 for each grade, and that is the principle--if one is the cause and the other the effect, make the percentages add to 100 for each category of the cause.

Why does it make sense this way? First, go over all the two-way tables and verify the generalization. Some may be difficult to decide cause and effect, and you will find these especially difficult to make sense except as descriptions--in which case it makes little difference which way you calculate the percentages. If there is a direction in the meaning (cause-effect), then this direction must be reflected in the calculations, otherwise the calculations *do not make sense*. (The percentages do not make the sense, of course, the students have to make sense from them). They do this by *comparing* percentages across grades for each category of plans, by comparing the 25 percent planning to complete Grade 13 at the end of ninth grade, with the 69 percent and more at the end of the other three grades. Comparing percentages does not make sense unless the percentages mean the same thing, and here the common meaning is "percentage of students *within a grade* who plan to complete Grade 13". This is a difficult principle to learn, but putting it at the end of a search for meaning may be the best chance we have for getting it across. Formulating it as an abstract rule about percentages will almost certainly not give the students something useful to take away from the lesson. In the end, we have to be able to write down the meaning in words if we are to make sense of opinion polls--or any application of percentages.

The period of reflection on *Making Sense of Opinion Polls* might therefore be launched by assigning as homework the review by each student of their active portfolio, charging them to come up with questions about the process, and in particular to ask themselves why tables might make sense one way and not another. When they come with their questions, deal with them. There can be no fixed agenda for the period of reflection, but success can be seen to depend upon two things: responding to the issues raised by students and drawing out some key generalizatons if the students do not raise them. It is not likely that useful reflection can be completed in just one or two periods, and one outcome might be a decision to go back and do more work on the problem set in order to understand how the sense-making comes about. There will normally be suggestions for the teacher in the teacher's version of each problem set.

Reinforcement Activities

1. Students devise ratios to show the following numbers.
   a. girls to boys in the class
   b. boys to students in the class
   c. right-handed to left-handed students in the class
   d. teachers to students in the class
   e. students whose names start with a vowel to students whose name starts with a consonant

2. Students shade in a 10 by 10 grid to represent the percentage of responses to a particular survey.

3. Students determine how the hours in one of their days is spent. e.g. sleep, school, eat, play, study, watch T.V. They then graph the percentage results on a pie graph, using a protractor for accuracy.

4. Students can represent percentages involved in the problem set on a one-metre long number line.

5. Students conduct a simple survey (three or four responses) using students of younger grades. They then record the results using a bar graph format.

Enrichment

1. Use the results from the survey your own group did. Prepare a table of percentages and comment on the results.

2. Decide on another topic for a survey. It should involve 3 or 4 questions and may be more suitable for a certain age level. Your survey should involve at least two classes or if you do it outside school, at least 50 to 100 people. Prepare a table of the results as well as a table of percentages. Write up a short report on your survey.

3. Take the percentage results from either the problem itself, or Follow Up 1, 2, or 3, and present it in two different forms (other than the table): pictograph, bar graph, pie graph etc. Discuss which presentation (including the table) is most effective. Why might one method be better in some cases than another?

4. Look in magazines and newspapers to find the result of a recent poll or survey. Discuss the results and report your findings to the class. You may wish to include your own group's answers or reaction to the survey.

5. Prepare a guide on how to use newspaper polls.

6. Collect samples of surveys that have been written in newspapers.

7. Generate a list of possible questions for doing a poll.

Independent Activities / Individual Homework Assignment

The following is only a first draft of an idea for an individual homework assignment. It will involve similar concepts and skills that were used in the main problem.

Table * : Numbers of Grade 9 and 10
Girls and Boys Who Chose
Specific Electives

	Art	Band	Computer Science	Drama	French
Gr. 9 Girls					
Gr. 9 Boys					
Gr.10 Girls					
Gr.10 Boys					
Total					

Problem 1:

Along the right-hand edge are the total number of students in the survey, by grade and by gender. The total number of answers from both sexes and both grades was ____. Add only certain row totals to find the number of girls who participated in the survey, the number of boys, the number of Grade 9 students, and the number of Gr.10 students. How do these subtotals relate to the total number of students in the survey?

Problem 2:

The column total give the number of students who chose a particular elective. Add the number in each column to see how many students chose certain electives. Again, divide these totals into subtotals representing gender and grade.

To be continued...

How to Use Polls Published in the Newspaper

Opposite is a photo copy of an article from the Toronto Star of April 28, 1988. Grade 8 classes might not be excited over the Meech Lake agreement, but it is important to Canada and we can use the article to illustrate how to develop material for use in class and for homework. The starting point for the studetns should be the raw frequencies - the number of people responding, rather than the percentage of people responding.

Newspapers and magazinges almost always publish only percentages in the tables, but they are now obliged by law to say in the text how many people were in the survey sample. We see from this article (fourth paragraph, right-hand column headed "Total" in the table with the big heading, GALLUP POLL. The number of people who said that the Meech Lake accord was a good thing for Canada was therefore 291 (28 percent of 1041, rounded off). This would be an exercise to assign to students if that were all there is to it. The problem is that the newspaper does not say how many were interviewed in Quebec. You might contact Gallup, but that

GALLUP POLL

Do you think the Meech Lake Accord will be a good thing for Canada?	Total	Quebec	Rest of Canada
A good thing for Canada	28%	32%	28%
Not a good thing	25	18	27
Can't say	47	50	47
In the Meech Lake agreement, do you feel the federal government is turning over too much power to the provinces?			
Turning over too much	28%	13%	31%
No, would not	32	39	30
Can't say	41	48	39
And do you approve or disapprove of the inclusion of Quebec in the constitution as a 'distinct society' within Canada?			
Approve	35%	49%	30%
Disapprove	44	19	52
Can't say	22	32	17

Only 28% now support the constitutional accord latest Gallup poll says

By David Vienneau Toronto Star

OTTAWA — Just 28 per cent of Canadians think the Meech Lake constitutional accord would be good for Canada, according to a Gallup poll released today.

In the poll, conducted April 6-9, Canadians were asked: "Over-all, do you think the Meech Lake accord will be a good thing or not a good thing for Canada?"

The 28 per cent who said it would be good amounts to half the number who felt this way a year ago. Another 25 per cent in today's poll said it would not be good. Forty-seven per cent could not say.

Gallup also asked people whether they approved of the accord's designation of Quebec as a "distinct society."

Thirty-five per cent approved, 44 per cent disapproved and 22 per cent could not say.

End boycott

The Meech Lake accord, designed to end Quebec's boycott of the Constitution, was signed at a meeting between Prime Minister Brian Mulroney and the premiers last spring.

Besides giving Quebec the distinct society status, it would let the provinces appoint senators and Supreme Court judges and make it more difficult for the territories to become provinces.

In addition, the accord would limit the right of the federal government to introduce new national shared-cost programs like medicare.

Gallup, in a statement released with the poll, said: "The Canadian public, along with the Canadian Senate, appears to have reservations about the Meech Lake accord."

The Senate recently approved an amended version of the accord in a bid to provide greater protection for women, native people and minority-language groups.

To become law, the accord has to be approved by Parliament and all provinces by June, 1990. Saskatchewan, Alberta and Quebec have so far ratified the deal.

A similar Gallup poll conducted last year, after the deal was signed April 30, found that 56 per cent of respondents supported the deal, while 26 per cent said it would not be in the best interests of the country.

The poll also shows that many Canadians know little about Meech Lake.

Of the 1,041 adults who were interviewed by Gallup, only 34 per cent were familiar with the accord, down from 42 per cent a year ago. Of those familiar with the accord in today's poll, 43 per cent supported it and 42 per cent were opposed.

Results of the survey are considered accurate within a margin of four percentage points, 19 in 20 times.

Strongest in Quebec

Support for the accord is strongest in Quebec, which refused to agree to the 1982 constitutional deal reached by then-prime minister Pierre Trudeau's federal government and nine provinces.

Forty-nine per cent of Quebecers said they supported the distinct society provision, while 19 per cent were opposed and 32 per cent were undecided.

Finally, 28 per cent of those surveyed said the accord would result in Ottawa turning over too much power to the provinces, compared to 32 per cent who said it would not and 41 per cent who were undecided.

would take time and might be done once. A shortcut is to use the knowledge that all responsible survey companies (of which Gallup is one) take samples proportionate to the population. Since the population of Quebec is about 8.5 million and the population of Canada 22 million, the sample size for Quebec was about 402 ((8.5/22) X 1041). This is close enough for our purposes, and taking the number as 402 makes it more realistic. The sample for the "Rest of Canada" is therefore taken to be 639, leading to the table of frequencies below.

the Meech Lake Accord a good thing for Canada?

	Quebec	Rest
A good thing	129	136
Not a good thing	72	173
Can't say	201	300

too much power to the provinces?

too much	52	198
No	157	192
Can't say	193	249

inclusion of Quebec as 'distinct society'?

Approve	197	198
Disapprove	76	332
Can't say	129	109

Meech Lake Polls

Students' Version

The Meech Lake Accord is important to Canada. It was designed to end Quebec's boycott of the Canadian Constitution. As well as giving Quebec status as a distinct society, it would allow provinces to select all the nominees for Senators and Supreme Court Judges. It would also make it more difficult for the territories to become provinces.

The Accord would limit the right of the federal government to introduce new national shared-cost programs (such as health care). Amendments have been proposed that would increase the protection provided for women, native people and minority language groups, but some provinces have said they will not accept any amendments. The Accord must be approved by Parliament and all the Provinces by June, 1990 in order to become law. As of April 1988, only Saskatchewan, Alberta and Quebec had signed the agreement.

The Gallup Organization conducted a survey of 1,041 adults during April 4-6 1988 to determine what Canadians think about the Meech Lake Accord. Three questions were asked of each of the people surveyed, and the results were published in the Toronto Star, April 28, 1988. The following tables provide the frequencies used in preparing the published report, that is, the number of people who answered questions in a particular way.

Views on the Meech Lake Accord

Table 1: Do you think the Meech Lake Accord will be a good thing for Canada?

Opinion	Quebec	Rest of Canada
Yes	129	166
No	72	173
Can't Say	201	300

Table 2: In the Meech Lake Agreement, do you feel the federal government is turning over too much power to the provinces?

Opinion	Quebec	Rest of Canada
Yes	52	198
No	157	192
Can't Say	193	249

Table 3: Do you approve or disapprove of the inclusion of Quebec in the Constitution as a 'distinct society' within Canada?

Opinion	Quebec	Rest of Canada
Approve	197	198
Disappove	76	332
Can't Say	129	109

Problem One:

To Think About

Look at Table 1. What do the numbers tell you about how much Canadians know about Meech Lake? What part of Canada is more supportive of Meech Lake; Quebec or the rest? Why do you think that is so? What percentage of the people answering the survey were from Quebec? What percentage of the rest of Canada thought the Meech Lake Accord would be a good thing for Canada?

Problem Two:

To Think About

Look at Table 2. Do more people have an opinion than in Table 1? What does "turning over too much power to the provinces" mean? Why do you think there is a difference in opinion between Quebec and the rest of Canada? What percent of the people feel too much power will be turned over to the provinces?

Problem Three:

To Think About

In Table 3 more people voice an opinion. Why do you think that has happened? How many people believe Quebec should be thought of as a distinct society? What percentage of the people from the rest of Canada had an opinion on this question? How much of an increase is this over the other two questions?

Why do you think there were so many people in each table who chose "Can't Say" as their choice?

Problem Four:

To Think About

Is it reasonable that the numbers for Quebec are smaller than the numbers for the rest of Canada? Why might the numbers be different?

Assuming 8.5 million people in Quebec and 22 million people in Canada. What percent of Canadians live in Quebec? Compare this number with the percentage who responded to the survey.

Problem Five:

To Think About

How would your group answer the three questions in the survey?

To Do

In your group, take a survey using the three questions. (You may want to use a secret ballot). Tabulate your results and get the results from each of the other groups.

Set up a Table using the results from each of the groups. How does your class compare with the rest of Canada? How does it compare with Quebec? Compare your group with the class totals. Set up two tables of your results: one showing the raw data and the other showing the percentage distributions.

What are some limitation to these sorts of comparisons?

Poll of Views on Examinations

Students' Version

In 1987, a survey on the education system was conducted in England. Three thousand adults were interviewed about their opinions on many aspects of the British education system.

As you likely know, many people experience a lot of pressure and may not perform to the best of their ability when writing an exam. People were asked whether they disagreed or agreed with the following statements: "Formal examinations are the best way to judge the ability of pupils." and "So much attention is given to exam results that a pupil's everyday classroom work counts for too little."

The following tables give the number of people who agreed or disagreed for six age groups. The information and numbers are based on an article published November 4, 1988 in The Times Educational Supplement (London).

Table 1: The number of people who agreed or disagreed with the statement "Formal Exams are the best way to judge the ability of pupils"

Age of respondent	18-24	25-34	35-44	45-54	55-64	65+
Agree strongly	3	25	90	80	42	11
Agree	16	118	352	382	193	36
Neutral	10	80	161	181	71	14
Disagree	33	168	302	312	97	12
Disagree strongly	13	25	90	40	13	1
Don't know/no answer		4	10	10	4	1

Table 2: Number of people who agreed or disagreed with the statement "So much attention is given to exam results that a pupil's everyday classroom work counts for too little"

	18-24	25-34	35-44	45-54	55-64	65+
Agree Strongly	20	88	171	131	80	12
Agree	40	223	492	583	206	34
Neutral	7	55	111	110	63	12
Disagree	8	46	211	161	67	12
Disagree Strongly		8	20	20	4	2
Don't know/no answer						3

To Think About

1. Is it meaningful to compare the numbers in Table 1? Why?
2. What about Table 2? Are those numbers meaningful as they appear in the table? Why?
3. How will you have to alter the numbers to make them meaningful?

Look at each of the tables individually.

1. Which groups differ the most?
2. Where is the greatest difference, when they disagree or when they agree?
3. When are the groups most alike?
4. What would happen if there were no 'Neutral'?

Future prospects for the year 2001

The January 2, 1989 issue of *Maclean's* magazine published results of a survey taken by Decima Research Ltd. Fifteen hundred people were interviewed about their views on a variety of subjects.

One of the questions concerned future prospects. People were asked, "By the year 2001 do you think..." and then given eight different items. They were asked to respond yes or no to each item.

The following table gives the number of respondents answering yes or no to each of the eight items.

Table 1: Number of people answering yes or no to the question "By the year 2001 do you think..."

By the year 2001 do you think:	Yes	No	No Answer
Tap water will still be drinkable	825	660	15
Average families may afford city houses	360	1125	15
Better people will be in politics	735	705	60
Public health care will be available to all	960	495	45
It will be safe to walk around in cities	480	990	30
Pay rates will keep pace with inflation	915	555	30
Canada will be using U.S. currency	540	915	45
Asia will be the most powerful world region	585	810	105

To Think About

1. What do the numbers in the table mean?
2. What could you use as a guide in determining which questions were more important to the people responding ?
3. What seems to be the most important question(s)? Why do you think so?
4. What items show a fairly even split in people's opinions?

To Do

Take a survey of your group for the same eight items. Do it by secret ballot and then calculate the results.Compare your group results with the other groups. Compare the class responses with the survey responses. Have your class respond to the items and then make up a table with the results.

To Think About

1. What question(s) were most important for your group; for the class?
2. What are some other items you might be concerned about for the year 2001?
3. As a group, make up a list of your concerns.
4. What do the majority of Canadians think will happen by the year 2001?
   What do the majority of Canadians think will not happen by the year 2001?
   What items show a fairly even split in peoples opinions?

Form "B" of problem set (original form)

Making Sense From Opinion Polls

Students' Version

Businesses such as *The Gallop Poll* and *Canadian Facts* make their money by predicting the future. They ask a thousand or so people a few questions, and from their answers they predict how Canadians will vote and what they will buy. Choosing the people to ask and getting their answers is called ***polling***, the results are called ***polls***, or ***surveys***. How do they make the predictions? They use science, imagination and lots of simple calculations.

A new poll is reported on television and in the newspapers nearly every day. Some are done just to find out what people are thinking - about free trade, nuclear power or abortion, for example. A few years ago (when there was still Grade 13), the Ontario Institute for Studies in Education (OISE) took a poll of students across Ontario in Grades 7, 8, 9 and 10, asking their opinions on a number of matters and also asking about their plans for future schooling. One reason for the question was to find out if plans changed as students progress through the grades. Only a few thousand were included in the poll, but they were carefully chosen to be as much like the whole Grade 7 to 10 group as possible.

The first step in making sense of the answers is to *tabulate* them - count how many people gave each answer. Table 1 shows the counts of answers to the question:

In the next few years, I plan to

a. *complete Grade 13.*
b. *complete Grade 12, but not Grade 13.*
c. *leave school before completing Grade 12.*

Table 1: Numbers of Ontario Students in Grades 7, 8, 9 and 10 Who Chose Each Option in a Survey of Their Plans for Finishing High School

Grade	Complete Grade 13	Complete Grade 12 but not Grade 13	Leave school before completing Grade 12	Total
7	729	196	19	944
8	651	264	28	943
9	178	501	36	715
10	667	229	18	914
Total	2225			

Problem One

To Think About

Along the right-hand edge of Table 1 are the total number of students in the *survey*, in each grade. There were 914 answers from Grade 10, for example, but only 715 from Grade 9.

To Do

Check the totals by adding the numbers in each row.

To Think About

Along the bottom are the total number of students who planned to complete Grade 13, Grade 12 or leave before completing Grade 12.

For example, there were 2225 students who planned to complete Grade 13.

To Do

Check the totals by adding the numbers in each column.

To Think About

The total number of answers from all grades was 3516. How do you know this?

To Do

Add the column totals to check this grand total.

To Discuss

How else could you check this grand total?

Problem Two:

To Think About

Is it reasonable for the total number of answers from Grade 9 to be smaller than from the other grades? Why do you think the numbers were different? How would you know? What do you think when we tell you that about the same number of Grade 9 and Grade 10 students were included in the survey? Why might fewer Grade 9s respond?

Why is it awkward to compare the counts in any of the columns from one grade with those of another?

To Do

Take a *survey* using the same questions in your own class and one other. Decide in your group how you will do this. You may want to do it by 'secret ballot'. Prepare you own table of results.

To Discuss

Do the students in your *survey* have different plans than the Grade 8's in the problem? Your numbers will be smaller than the ones in the problem but you can get a feel for surveys just by doing it in one class. If you took a *survey* of more than one class, you can compare the results from the different classes.

Problem Three:

To Think About

The way most people try to make sense of polls such as this one is to convert the counts to percentages. For example, if the numbers in Table 1 were expressed in percents, you could say that "sixty-three percent of students in Grades 7 to 10 said they plan to complete Grade 13. Only three percent plan to leave school before completing Grade 12".

Percentages make comparisons more meaningful because we are comparing several proportions of the same number.

To Do

Express the grade totals as a percentage of the grand total. Use them to describe how the total number of students who responded to the question were divided among the four grades. For example, 944 of the 3516 total number of students were in Grade 7. You could say that 27 percent of the total number of students in the survey were in Grade 7.

Next, express each column total at the bottom as a percentage of the grand total (You will need this information for the next problem).

To Discuss

What percent of the total number of students in the survey were in Grade 7? 8? 9? 10? Which grade had the largest percentage of total respondents? the smallest? How does this compare to what you thought using the numbers in Problem 2? (Look back to Problem 2, **To Think About**)

Problem Four:

To Think About

To find out whether plans change from grade to grade, we have to compare percentages who choose each answer *within each grade*. Since we want to compare grades, we work separately within each grade and compare later.

To Do

Start with row one ,Grade 7, and express each count as a percentage of the row total (944). For example, 729 of the 944 Grade 7s plan to complete Grade 13. You could say that 77 percent of the Grade 7s plan to complete Grade 13. Do this for each of the four rows. Your result should look like Table 2.

To Discuss

How can you quickly check your calculations of percents within each grade? Now study the percentages and see what meaning you can make of them. There is a startling result, which you may have suspected from the counts but which strikes the eyes when you look at the table of percentages.

Table 2: Frequencies from Table 1
Converted to Percentages

Grade	Complete Grade 13	Complete Grade 12 but not Grade 13	Leave school before completing Grade 12	Total
7	77	21	2	100
8	69	28	3	100
9	25	70	5	100
10	73	25	2	100
Total	63	34	3	100

The Community Center Gets a Swimming Pool

The municipal council provided money for a small community centre several years ago--an arena for skating and hockey, meeting rooms, a games room and snack bar. The space was supposed to be big enough to accommodate a swimming pool sometime in the future, when funds might become available. A sketch of the *Community Centre* is attached. A resident of the community has now offered to donate a pool, complete with water pumps, filters and the like, if the council will provide proper surroundings and agree to operate and maintain it. The pool is an unusual one (See Figure 1). The community centre staff and Board of Directors have agreed that the pool is large enough but they don't know (a) whether it will fit on the community centre lot, or (b) what the required surroundings will cost (deck, fence, and the like).

Community centre staff have recommended an outdoor pool, with provision for an inflatable all-weather cover. This, with other pool requirements, means that a rectangular concrete deck has to be built around the pool, with a minimum distance of 2.5 m from edge of pool to edge of deck. In keeping with the Ontario Building Code, the pool and its deck will have to be completely enclosed (for example, surrounded with a fence). The outside entrance has to be at least 10 m from the edge of the pool. The inflatable cover (when they get it) and the entrance will have to fit on the concrete deck. Fortunately, the pumps and filters can be located in an existing building next to the proposed pool site. The locker and shower rooms used for other sports at the community centre will be used, but washrooms have to be located near the pool.

Problem One: Use the sketch of the community centre property to find out whether there is room for the pool. (The property is located in a built up area, so there is no possibility of expansion.) It may help to make a larger sketch of the pool site itself, to scale and as accurate as you can manage. Use graph paper with fine lines, if available. The municipal building code should be consulted, because planning staff have said informally that they would not look favourably on an application for a variance.

Problem Two: Work out a first approximation to the cost of the smallest concrete deck that will accomodate the pool and the inflatable cover. Calculate the cost assuming that the small and large pools did not overlap (assume that the circles just touch at one point). Suppose that the cost of concrete delivered to the site is $84.50 a cubic metre and double that to include labour, steel reinforcement and other costs. (This price will vary from time to time and from place to place, of course.) Check with local suppliers to get a price in your community and ask a local contractor if doubling the cost of the concrete gives a reasonable estimate of total cost.) Assume the deck will be of a uniform thickness and make it as thin as the building code allows. Will this estimate of the cost of the deck be too low or too high?

Problem Three: Work out a better approximation to the cost of the deck. You might use fine graph paper to make a diagram, but also try using triangles and angle measurements to estimate the area of the pool. If you are using graph paper, include the scale (e.g. what number of squares = what number of metres.) Using your estimate(s) for the size of the deck, calculate how much more it would cost to make the deck 5 cm thicker than you decided in *Problem Two*. How much would it cost to make the deck as large (as long and as wide, that is) as the building lot? (Optional: Use known properties of circles to calculate the size of the overlap *exactly*, and compare this ideal figure with your earlier estimates.)

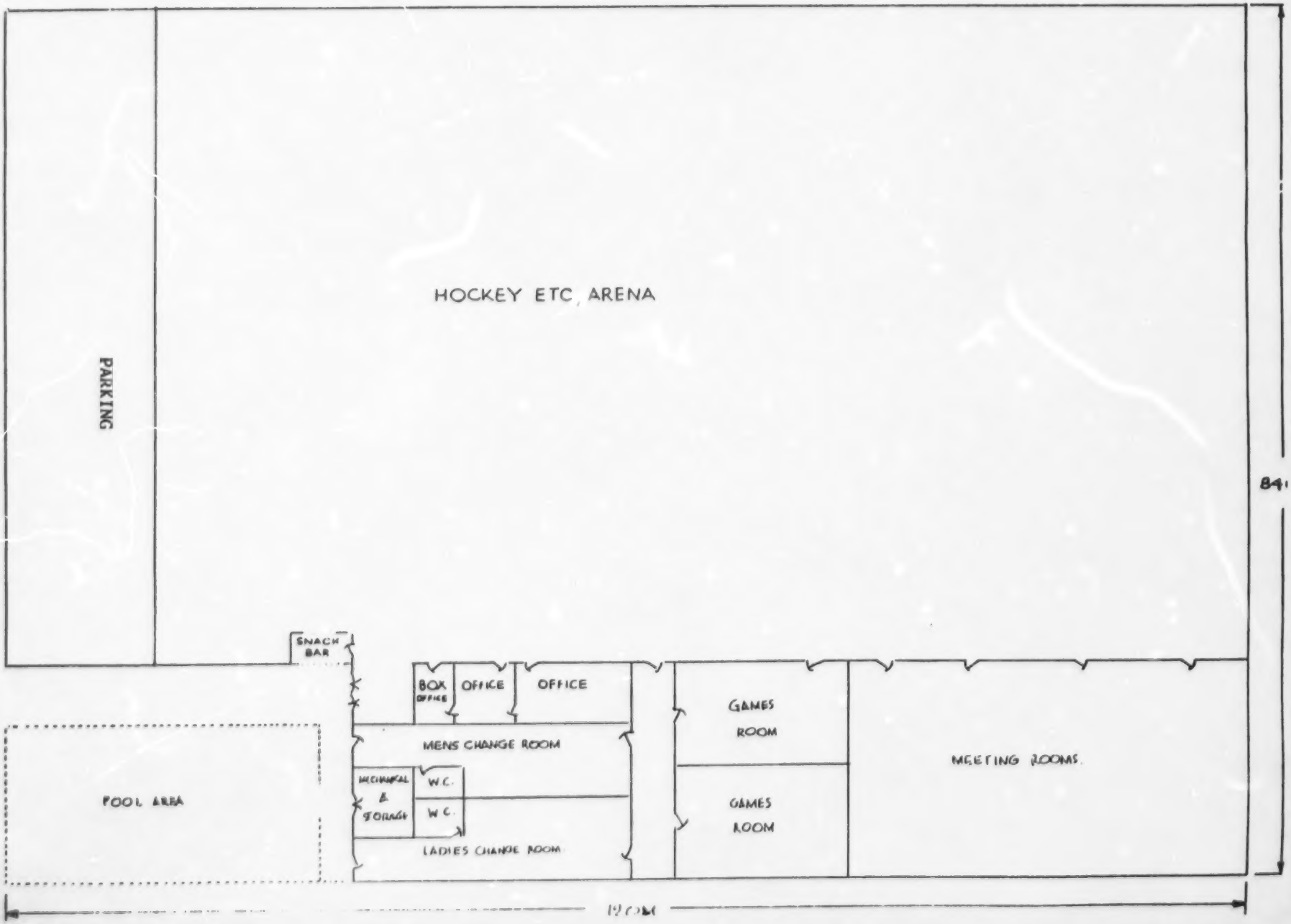
Problem Four: Suppose we scrapped the inflatable cover and just built the outdoor pool, with a two metre wide concrete deck around it, that is, with a circular deck, matching the shape of the pool. (Would that be permitted?) How much would we save on the deck alone?

Problem Five: How long would a plain rectangular pool be if it were 7 m wide and held the same amount of water as the keyhole pool? (As a first approximation, take the depth of the larger pool as a uniform 2 m.) What would you need to know to calculate exactly how much water the keyhole pool held? What would be the dimensions of the pool if we required it to be proportional to the pool site? If a rectangular pool design were used, would it cost more or less than the pool in Problem Four?

Problem Six: What would be the costs of the fences that would be required to enclose the pool and deck in the various patterns described above? Again, it will be necessary to consult the Building Code for size and character of fencing allowed. It will also be necessary to contact a local supplier for costs per metre of fencing plus cost of supporting materials and installation. Make a table showing the comparative costs.

Problem Seven: Write up a recommendation to the municipal council, including what sort of pool they should put where, with or without inflatable cover. Give a rationale for your recommendations and try to persuade them to your point of view. Use drawings or pictures as appropriate, and cite any experts you may have contacted.

COMMUNITY CENTRE



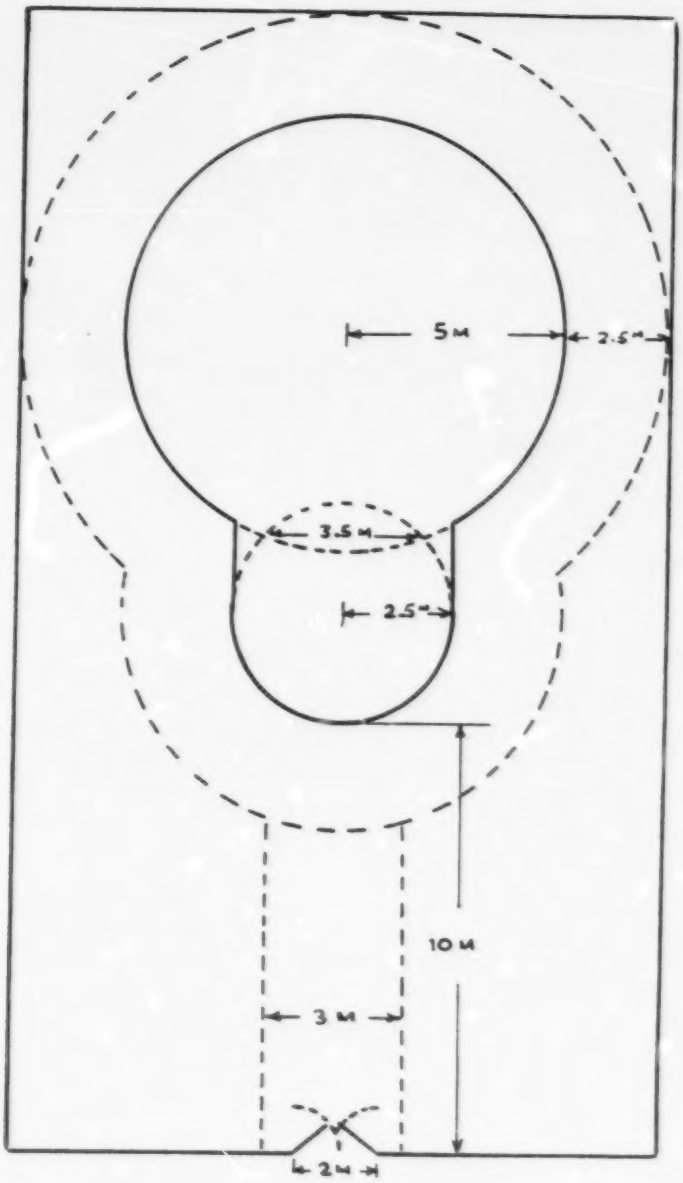


FIGURE 1 "KEYHOLE" SWIMMING POOL

X

Teacher's Guide. These are comments specific to this problem set. A general introduction to the methodology appears separately. The *Teacher's Guide* is to be refined in cooperation with teachers who try out the curriculum during '88-'89

Estimation, scales of measurement and elementary geometry (area of a circle and of a triangle) are called for in solving these problems. Scale drawings, graphs and graphical estimation are suggested as part of the method, so a page or two of fine-ruled graph paper for each student would be desirable. Students also have to find some requirements in the Building Code and use them to calculate the costs of fencing. The Building Code also provides extensions having to do with diving boards and safety equipment. Here are some suggestions for taking up the problem set, but teachers are encouraged to vary the time and order as suits their needs. In particular, Problem One (using the scale map to determine whether the pool will fit on the lot) can be done independently.

1. The scale map of the community centre property makes the pool site look very small, but that is a good point to discuss. Hockey arenas take up much more space than most pools. The keyhole pool sketch is done to a different scale, so it looks larger. Making a new sketch of the pool site, as suggested, using the scale of the pool, will quickly show whether there is a chance the pool will fit (there is). The reason for consulting the building code is to learn about decks, setbacks and fencing requirements needed in the other problems.

2. The most obvious way to estimate the cost of a deck would be to take the area of a rectangular deck and subtract the area taken up by the pool, but students should work together (perhaps in small groups) to come up with this approach. If the two circles do not overlap, the pool area is easily found (assuming they know how to calculate the area of a circle). This is suggested to the students as a hint and to introduce the concept of first (and subsequent) approximations. The building code will not provide all the information needed (the required thickness of the deck, for example). This is a social studies lesson and a feature of realistic problems. They will have to make educated guesses or seek out expert advice. Remind them this is a first approximation and suggest they make assumptions, keep careful notes and press on.

3. Problem Three provides a purpose for some simple, but abstract, mathematics--using inscribed triangles to calculate a new estimate of the pool area that takes account of overlap. A figure is included which should not be shown to students unless they come to a real impasse. The alternative is suggested of using graph paper to estimate the overlap, but this will likely be seen as unsatisfactory because of the difficulty of estimating the areas of partial squares at the edge of the circles. Give a gold star to anyone who suggests making a scale model from wood and weighing it to estimate the area. They might see that the ratio of the area of a scale model of a circle (or square or ...) to its weight is the same as the

ratio of the area of the scale model of the pool (unknown) to its weight. (This assumes careful modelling and uniform materials, of course.)

4. Problems Four, Five and Six are extensions that individuals, groups or everyone might take up. They call for considerable interpretation, as real problems usually do, so they might take unexpected forms. All the better. The building code contains many other challenges, especially in sections 26 to the end.

from Ontario Regulation 381/84 as amended by O. Reg. 146/85
under Health Protection and Promotion Act 1983
(Public Pools) May 1985

(3) Exposed piping within a public pool enclosure and inside the structure of the pool and appurtenant structures shall be identified by,

(a) colour coding with coloured bands at least twenty-five millimetres wide spaced along the pipe at intervals not greater than 1.20 metres; or

(b) painting the entire outer surface of the pipe,

in accordance with the following code:

chlorine	— yellow
potable water	— green

O. Reg. 381/84, s. 25.

CLASS A POOL

26.—(1) A Class A pool, the plans and specifications of which where approved or the construction of which was commenced after the 1st day of May, 1971 and before the 1st day of May, 1974, is exempt from clause 27 (1) (*a*), clauses 30 (1) (*e*), (*i*) and (*n*) and clauses 30 (4) (*a*) and (*f*).

(2) A Class A pool that was constructed after the 7th day of June, 1965 and before the 1st day of May, 1971 is exempt from clause 27 (1) (*a*), clauses 30 (1) (*e*) and (*g*), subclause 30 (1) (*h*) (iv), clauses 30 (1) (*i*) and (*n*), subclause 30 (1) (*t*) (i), clause 30 (1) (*w*), subsections 30 (4) and (5), clause 30 (6) (*a*) and section 31 provided that it is capable of being operated in compliance with the requirements of section 7.

(3) A Class A pool that was constructed before the 7th day of June, 1965 is exempt from subsection 24 (1), clauses 27 (1) (*a*) and (*b*) and sections 30 and 31 provided that it is capable of being operated in compliance with the requirements of section 7. O. Reg. 381/84, s. 26.

27.—(1) Subject to sections 31 and 32, a Class A pool shall be so constructed that,

(a) a volume of water not less than four times the total capacity of the pool can be filtered, disinfected and passed through the pool each day;

(b) dressing and locker rooms, toilets, urinals, hand-wash basins, drinking fountains and showers are provided in sufficient numbers to accommodate the bathers using the pool; and

(c) an emergency telephone is provided that is easily accessible from the deck and that is directly connected to an emergency service or the local telephone utility.

(2) Notwithstanding clause (1) (*b*) and clause 30 (11) (*e*), where a Class A pool is installed at a recreational camp, dressing, toilet and shower facilities shall be so located on the premises that they are convenient for the use of the bathers. O. Reg. 381/84, s. 27.

CLASS B POOL

28.—(1) A Class B pool, the plans and specifications of which where approved or the construction of which was commenced after the 1st day of May, 1971 and before the 1st day of May, 1974, is exempt from clauses 30 (1) (*e*), (*i*), (*k*) and (*p*) and subsections 30 (4) and (5).

(2) A Class B pool that was constructed before the 1st day of May, 1971 is exempt from subsection 24 (1), clause 29 (1) (*a*), subsection 29 (2) and sections 30 and 31 provided that it is capable of being operated in compliance with the requirements of section 7. O. Reg. 381/84, s. 28.

29.—(1) A Class B pool shall be so constructed that,

(a) a volume of water not less than three times the total capacity of the pool can be filtered, disinfected and passed through the pool each day; and

(b) a telephone no farther than thirty metres from the pool is accessible for emergency use.

(2) Where a Class B pool does not comply with the provisions of clause 30 (11) (*e*), the owner shall ensure that dressing, toilet and shower facilities are available elsewhere on the premises for the convenient use of the bathers.

(3) A Class B pool operated solely in conjunction with a club, day nursery, day camp or establishment or institution for the care of persons who are infirm or aged or for persons in custodial care is exempt from the provisions of subclauses 30 (1) (*h*) (i), (v) and (vi).

(4) A Class B pool operated solely in conjunction with an establishment or institution for the treatment of persons who are ill is exempt from the provisions of clauses 30 (1) (*c*) and (*g*) and subclauses 30 (1) (*h*) (i), (v) and (vi). O. Reg. 381/84, s. 29.

CLASS A AND CLASS B POOLS

30.—(1) Subject to sections 31 and 32, a public pool shall be so constructed that,

(a) access to the pool deck can be prevented when the pool is not open for use;

(b) floors, interior walls, interior partitions and the pool interior and deck have surfaces that permit convenient and thorough cleaning;

(c) the slope of the bottom of any portion of the pool having a water depth of less than 1.35 metres does not exceed 8 per cent and in portions having a depth greater than 1.35 metres and less than 2.00 metres the slope does not exceed 33 per cent;

(*d*) in water depth of 1.35 metres and less, the side and end walls, except at steps or recessed ladders, are vertical from the top of the walls to within 150 millimetres of the bottom and at no point is the water depth less than 0.75 metre;

(*e*) except for markings for safety or competition purposes, the submerged surfaces are finished white or light in colour;

(*f*) a black disc 150 millimetres in diameter on a white background is affixed to the bottom of the pool at its deepest point;

(*g*) the walls of the pool are equipped with recessed fittings to which can be attached safety lines supported by buoys to give a warning 300 millimetres or more in advance on the shallow sides of the breaks between gentle and steep bottom slopes;

(*h*) it is surrounded by a hard-surfaced deck that is provided solely for the use of bathers and persons engaged in safety supervision and operation of the pool and that is,

(i) not less than 1.80 metres wide and provides not less than 0.90 metre width of clear passage behind a diving board and its supporting structure,

(ii) sloped to waste drains or to adjacent lower ground at a slope between 2 and 4 per cent at an outdoor pool, and at an indoor pool, sloped to individually trapped waste drains at a slope between 1 and 4 per cent,

(iii) equipped with hose connections installed in convenient and safe locations for flushing the deck,

(iv) essentially flush with the walls of the pool so that the deck does not overhang the water by more than fifty millimetres,

(v) separated by a barrier from any permanent spectator gallery adjacent to the deck, and

(vi) clearly delineated, by markings or other means from the general area where one is provided;

(*i*) one or more ladders or steps are provided in the deep and shallow areas;

(*j*) a perimeter drain is provided where necessary to prevent surface water from the adjacent area draining on to the deck;

(*k*) it is provided with a device indicating the rate of flow of the recirculating water;

(*l*) clean water inlets are arranged to provide satisfactory distribution and circulation of clean water throughout the pool before it again enters the recirculation system;

(*m*) the pipelines and fittings terminating in the pool are provided with gratings or covers;

(*n*) it can be emptied in twelve hours or less through one or more drains and the area of the drain cover openings is such that the flow of water does not exceed,

(i) 0.45 metre per second through the openings of a grate, or

(ii) 1.80 metres per second through the opening of an anti-vortex fitting;

(*o*) it is provided with overflow gutters or surface skimmers of adequate capacity and design to remove surface film;

(*p*) up to 15 per cent of the total pool water volume can be withdrawn from the gutter or skimmer lines daily and discharged to waste drains;

(*q*) it is provided with a water meter to indicate and register the volume of all make-up water added to the pool or its recirculation system;

(*r*) no water other than make-up water and clean water can be admitted to it;

(*s*) a chlorinator or chemical feeder is installed, provided with a means for regulating the dosage and capable of providing the equivalent of not less than,

(i) 300 grams of available chlorine per day per 10,000 litres of total pool capacity in the case of an outdoor pool, or

(ii) 200 grams of available chlorine per day per 10,000 litres of total pool capacity in the case of an indoor pool,

or a brominator is installed of sufficient capacity to maintain in the pool water a total bromine residual of three milligrams per litre;

(*t*) where compressed chlorine gas is used, a separate chlorine cylinder storage room is provided that is,

(i) located above ground with an exit door opening outwardly and directly to the outdoors with screened openings to the outdoors located within 150 millimetres of the floor and at the ceiling in the ratio of twenty square centimetres of opening to one square metre of floor area,

(ii) equipped with a platform weigh scale of not less than 135 kilograms capacity for each chlorine cylinder in use, and

(iii) equipped with mechanical ventilation capable of producing at least thirty air changes per hour, taking suction at a maximum of 0.90 metre above floor level and discharging at least 2.50 metres above ground level directly to the outdoors so as to take into account adjacent air intakes and the direction of the prevailing wind;

(*u*) provisions are made for the safe storage and handling of all chemicals required in the pool operation, and such storage and handling facilities shall include a hose connection, floor drainage and ventilation;

(*v*) foot sprays to wash the feet by a spray running freely to waste are provided for pools where bathers entering or using the pool deck area must walk in bare feet over surfaces not subject to regular cleaning and sanitizing; and

(*w*) provision is made for vacuum cleaning submerged surfaces of the pool.

(2) Gas chlorination equipment shall be,

(*a*) so designed that the chlorine solution feed is automatically terminated whenever the recirculation system ceases to supply clean water to the pool; and

(*b*) installed by and under the supervision of a person or persons trained in the installation of gas chlorination equipment.

(3) Where a public pool is equipped with a diving board or diving platform the board or platform shall have a non-slip surface finish.

(4) Where a public pool is equipped with a permanently installed diving board or diving platform not greater than three metres in height above the water, the pool shall be so constructed that,

(*a*) the depth of water at the end of the board or platform and for a semi-circle of three metres radius beyond the end is not less than,

(i) 2.75 metres, for a board 0.60 metre or less in height above the water,

(ii) three metres, for a board or platform greater than 0.60 metre and not exceeding one metre in height above the water, and

(iii) 3.65 metres, for a board or platform greater than one metre and not exceeding three metres in height above the water;

(*b*) the end of the board or platform is not less than nine metres in horizontal distance from any point having a water depth of 1.35 metres or less, except that where a Class B pool is equipped with a board 0.60 metre or less in height above the water, the end of the board may be less than nine metres but not less than 7.50 metres in horizontal distance from any point having a water depth of 1.35 metres or less, provided that a warning notice, on which is printed in letters at least 150 millimetres high, DANGER—AVOID DEEP OR LONG DIVES, is posted in a location clearly visible to divers;

(*c*) the lateral distance from the centre line of a board or platform to another board or platform is not less than 2.75 metres;

(*d*) the lateral distance from a pool wall to the centre line of a board is not less than,

(i) three metres, for a board one metre or less in height above the water, and

(ii) 3.60 metres, for a board greater than one metre and not exceeding three metres in height above the water;

(*e*) a board or platform 0.60 metre or less in height above the water projects a distance of 0.90 metre or more from the pool wall under it, a board greater than 0.60 metre in height above the water projects a distance of 1.50 metres or more from the pool wall under it and a platform greater than 0.60 metre in height above the water projects a distance of 1.20 metres or more from the pool wall under it; and

(*f*) the height of the ceiling or the distance of any other obstruction to a diver is not less than,

(i) 3.65 metres above a board of 3.65 metres or less in length and 0.60 metre or less in height above the water,

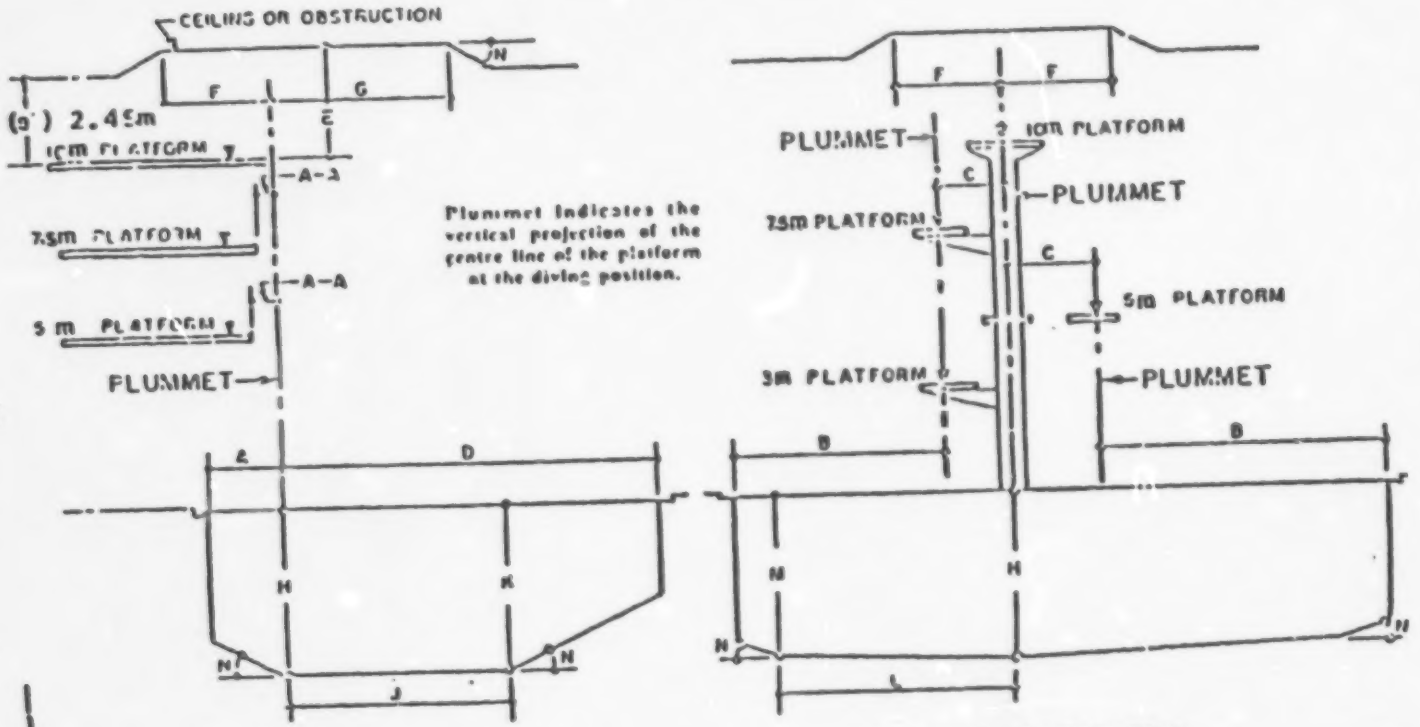
(ii) five metres above a board greater than 0.60 metre in height above the water, and

(iii) three metres above a platform.

(5) Where a public pool is equipped with one or more diving platforms greater than three metres in height above the water the pool shall be so constructed that,

(*a*) the dimensions defining the spacing of the platforms, the pool structure dimensions and the water depths in that portion of the pool that is required for diving are in conformance with the following Diagram and Table:

DIAGRAM


CEILING OR OBSTRUCTION
N
F
G
(9') 2.45m
E
10m PLATFORM
A-A
7.5m PLATFORM
A-A
5 m PLATFORM
PLUMMET
Plummet indicates the vertical projection of the centre line of the platform at the diving position.
C
D
H
K
N
J
F
F
PLUMMET
10m PLATFORM
C
PLUMMET
7.5m PLATFORM
C
5m PLATFORM
3m PLATFORM
PLUMMET
B
B
N
H
N
N
L
LONGITUDINAL SECTION
CROSS SECTION

TABLE

MINIMUM DIMENSIONS IN METRES

	5-Metre Platform	7.5-Metre Platform	10-Metre Platform
A From Plummet to pool wall under platform	1.20 m	1.50 m	1.50 m
A-A From Plummet back to board or platform directly below	0.75 m	0.75 m	0.75 m
B From Plummet to pool wall at side	4.30 m	4.60 m	5.20 m
C From Plummet to adjacent Plummet	2.10 m	2.10 m of 5-metre platform	2.75 m
D From Plummet to pool wall ahead	10.40 m	11.00 m	13.70 m
E Unobstructed headroom at Plummet	3.00 m	3.20 m	3.40 m
F Distance over which unobstructed headroom is maintained, behind and each side of Plummet	2.75 m	2.75 m	2.75 m
G Distance over which unobstructed headroom is maintained, ahead of Plummet	5.00 m	5.00 m	6.00 m

H	Depth of water at Plummet	3.65 m		4.10 m		4.50 m		
J K	Distance J, and depthof water K. ahead of Plummet	J	K	J	K	J	K	
		6.00 m	3.60 m	8.00 m	4.00 m	12.20 m	4.30 m	
L M	Distance L, and depth of water M, each side of Plummet	L	M	L	M	L	M	
		4.30 m	3.60 m	4.60 m	4.00 m	5.20 m	4.30 m	
N	Maximum angle of slope to horizontal	30 degrees						

(*b*) it is provided with a gate or other device which can be locked to control access to the platforms; and

(*c*) it is designed solely for diving off the platforms, or its walls are equipped with recessed fittings to which can be attached double safety lines 300 millimetres apart supported by buoys located at clear distances of 11.60 metres, 12.50 metres and 15.25 metres, for 5-metre, 7.5-metre and 10-metre platforms, respectively, from the wall under such platforms, or a rigid barrier is provided that is capable of being positioned parallel to the wall under the platforms at the appropriate distance as specified herein.

(6) Where a public pool is an indoor pool or where it is an outdoor pool that is used after sundown, a lighting system shall be provided,

(*a*) that will maintain at any point on the deck and the pool water surface an illumination of not less than,

(i) 215 lux in the case of an indoor pool, and

(ii) 110 lux in the case of an outdoor pool,

and such that underwater areas of pool and other appurtenances are clearly visible; and

(*b*) having independent emergency lighting that automatically operates whenever the normal supply to the pool lighting panel fails and so arranged that the underwater areas of the pool, the deck, toilet, shower and locker areas and exit passage-ways are adequately lit to facilitate prompt evacuation.

(7) Notwithstanding the provisions of clause (1) (*b*), where a public pool is installed on the surface of the ground or on a hard-surfaced floor or pavement and has a constant water depth not exceeding 1.10 metres and a water surface not exceeding ninety-three square metres, the deck may be replaced by a walkway surrounding the pool having,

(*a*) an unobstructed width of not less than 0.90 metre;

(*b*) an elevation of not less than seventy-five millimetres above grade or floor elevation;

(*c*) six millimetres wide openings for drainage; and

(*d*) a surface that is capable of being maintained in a safe and sanitary condition.

(8) Notwithstanding clauses (1) (*d*) and (*h*), where a public pool has water depths not exceeding 1.50 metres and a water surface not exceeding ninety-three square metres, the deck contiguous to not more than 50 per cent of the total perimeter of the pool may be replaced by one or more ramps within or outside the pool that will permit a bather seated in a wheel chair so constructed for the purpose to enter the water.

(9) A ramp referred to in subsection (8) shall have,

(*a*) a slope not exceeding 11 per cent where the ramp is submerged and where the ramp is outside the pool, a slope not exceeding 8 per cent;

(*b*) a width of 1.10 metres or more;

(*c*) a curb or other means designed to prevent a wheel chair and its occupant from falling into the pool;

(*d*) a handrail running parallel to the slope at a height of 0.80 metre along each side of the ramp;

(*e*) a surface finish that is capable of being maintained clean, sanitary and free from slipperiness; and

(*f*) finishes for the submerged portions of the ramp and curb, where one is provided, that are of colours or shades differing from one another and from that of the pool walls and bottom.

(10) Where a public pool is provided with one or more ramps of a type referred to in subsection (8), the pool shall be so constructed that,

(*a*) the water depth at the bottom of a submerged ramp is not less than 0.60 metre and not greater than 0.90 metre;

(*b*) a hard-surfaced walkway that is not less than 0.75 metre wide is provided contiguous to a submerged ramp where one is provided, together with a removable barrier separating it from the deck and bearing a conspicuous notice on which is printed in letters at least twenty-five millimetres high:

BATHERS ARE NOT ALLOWED BEYOND THIS POINT

(*c*) a removable barrier is provided on the deck separating it from a ramp that is not submerged and bearing a conspicuous notice on which is printed in letters at least twenty-five millimetres high:

UNSUPERVISED BATHERS ARE NOT ALLOWED BEYOND THIS POINT

(*d*) a landing not less than 1.50 metres in length and at least 1.10 metres wide is provided at the bottom of each ramp;

(*e*) the landing at the bottom of a ramp that is not submerged is not less than 0.45 metre and not exceeding 0.55 metre below the top of the wall separating it from the pool and has a floor drain at its lowest point;

(*f*) the top of the wall between the pool and a ramp that is not submerged is not less than 250 millimetres and not exceeding 300 millimetres in width;

(*g*) the water depths are clearly marked in figures not less than 100 millimetres high in appropriate locations on top of the wall separating the pool from a ramp that is not submerged;

(*h*) the deck is provided with a curb having a height of fifty millimetres, rounded edges and a coved base;

(*i*) the top of the pool walls and the curb are provided with a raised nosing to serve as a fingerhold for the use of bathers in the water; and

(*j*) a notice on which is printed in letters at least 150 millimetres high,

CAUTION—NO DIVING

is posted conspicuously on each wall or fence line enclosing the pool.

(11) Dressing and locker rooms, showers and toilets in a public pool shall be so constructed and equipped that,

(*a*) the floor and wall joints are coved;

(*b*) the interior partitions of the dressing rooms and toilet rooms leave a gap of 300 millimetres above the floor level;

(*c*) all plumbing fixtures are supplied with potable water at a pressure of not less than 140 kilopascals;

(*d*) there is hot and cold water available in the shower bath facilities with a tempering device on the hot water system to prevent scalding;

(*e*) subject to subsections 27 (2) and 29 (2), the dressing and locker rooms, urinals and toilets are so located that following their use bathers must pass through the shower area to reach the deck;

(*f*) walls or partitions ensure privacy of the dressing rooms and shower areas;

(*g*) the floors in the toilet and shower areas and passage ways used by bathers are of hard-surfaced material, and slope to waste drains at a minimum of one per cent;

(*h*) there are hose connections installed in convenient and safe locations for flushing the walls and floors in the toilet and shower areas; and

(*i*) dressing and locker room floors may be easily cleaned.

(12) Where a public pool is used by both sexes simultaneously, the accommodations mentioned in subsection (11) shall be provided separately for each sex. O. Reg. 381/84, s. 30.

MODIFIED POOL

31.—(1) A modified pool is exempt from the provisions of clause 27 (1) (*a*) and clauses 30 (1) (*c*), (*d*), (*e*), (*f*), (*g*), (*h*), (*i*), (*m*) and (*n*).

(2) A modified pool shall be,

(*a*) paved with portland cement concrete, asphalt concrete or any other material approved by the Minister and shall have the underwater area finished in a light colour and capable of being refinished in a light colour;

(*b*) so constructed that at no place does,

(i) the slope of the bottom exceed 8 per cent, and

(ii) the depth of the water exceed 1.80 metres;

(*c*) so constructed that the entire pool is surrounded by a deck that,

(i) is at least three metres wide,

(ii) has a continuous crest 100 millimetres high above the water surface, and is paved with a material required under clause (*a*), and

(iii) is sloped away from the crest so that ponding of water does not occur and surface drainage from beyond the perimeter is excluded from the deck and the pool;

(*d*) so constructed that a volume of water not less than three times the total capacity of the pool can be filtered, disinfected and passed through the pool each day;

(*e*) so constructed that pipelines and fittings terminating in the pool are fitted with grilles or covers;

(*f*) provided with two or more drain fittings covered with protective gratings having openings totalling not less than ten times the area of an outlet pipe that is connected to the recirculation system and that is capable of draining the pool completely; and

(*g*) provided with continuous black markings on the bottom 150 millimetres wide where the water depth is 0.60 metre and 300 millimetres wide where the water depth is 1.20 metres.

(3) No person shall install a diving board or diving platform in a modified pool. O. Reg. 381/84, s. 31.

WAVE ACTION POOL

32.—(1) A wave action pool is exempt from the provisions of clauses 27 (1) (*a*), 29 (1) (*a*) and 30 (1) (*c*), (*d*), (*h*), (*i*), (*o*) and (*s*).

(2) A wave action pool shall be so constructed that,

(*a*) the pool walls are vertical from the still water surface to within 150 millimetres of the bottom;

(*b*) the slope of the bottom of any portion of the pool having a water depth of less than one metre does not exceed 8 per cent, and in portions having a water depth greater than one metre, the slope does not exceed 11 per cent;

(*c*) the shallow end of the pool has immediately adjacent to it a hard-surfaced deck not less than three metres wide for the use of the bathers and persons engaged in safety supervision and operation of the pool;

(*d*) the walls of the pool have immediately adjacent to them a hard-surfaced deck not less than 1.50 metres wide for the egress of bathers from the pool and for the use of persons engaged in safety supervision and operation of the pool;

(*e*) the decks are,

(i) sloped to waste drains or adjacent lower ground at a slope of 2 or more per cent up to and including 4 per cent,

(ii) equipped with hose connections installed in convenient and safe locations for flushing the deck, and

(iii) essentially flush with the walls of the pool so that a deck does not overhang the water more than fifty millimetres;

(*f*) sets of recessed steps and vertical grab bars are provided at intervals not exceeding 7.50 metres in the side walls adjacent to the portion of the pool where the water depth exceeds one metre in locations not closer than three metres to the corners at the deep end of the pool;

(*g*) except at the recessed steps, each deck adjacent to that portion of the pool where the still water depth is 2.30 metres or less is provided with a wall or barrier supported by posts located one metre or less from the edge and one metre in height to which are affixed notices at intervals not exceeding 7.50 metres signifying clearly that jumping or diving into the pool is not permitted in this area;

(*h*) bathers have no access to the electrical and mechanical equipment, chemicals and chemical feeders required for the operation of the pool;

(*i*) it is provided with skimming devices of adequate capacity, design and location to remove surface film during the periods when no waves are induced in the pool;

Banking plays an important part in our lives. Each of us should know what a bank can do for us and how to calculate what we gain from using a bank. We should also look at what a bank gains when it helps us.

Banks take care of money. Since we have had banks people have not had to have extra socks to keep their money in and although some people still keep their money in holes in the wall or under their mattress, the banks are generally seen as a safer place to store your money and leave it to grow a little on its own.

While you are still at school, you often do not have much extra money. But sometimes you can get a job delivering papers, shovelling snow or cutting lawns to earn money. Or even helping at home you can earn money. Or maybe you get an allowance from your family and you have a little left over each week. It takes very little to get started with the bank.

How do we decide to which bank we will give our business? That requires that we do a little work. All banks pay the same amount of interest. They have to do that to be competitive. (If they did not, the bank that paid the most would get all the business). What they do is pay the interest in different ways. It is how they pay the interest that determines exactly how much money you get when you let the bank take care of your money.

Our first decision as to what bank to use may be decided by choosing the bank closest to us. It would also be a good idea to visit the banks nearby at different times of the day, count how many people are waiting at each of the banks on each of the days of the week for two weeks (a group of you could share that job). It would be good to count the number of people waiting for the bank to open, the number of people there between 12:00 and 13:00, and the number of people still waiting to be served at the end of the banking day (when the bank closes). The class could then make a series of tables showing the number of people using the different banks at the same time on the same days. We would then have a second reason for choosing whichever bank we choose: the one that would keep us waiting the least amount of time.

What about the money the bank will pay on our money? If all the banks are paying 6% per annum, than they appear to be all paying the same amount of money. But 6% per annum only means that 6% is paid to you during the year, it does not say how the money is calculated. The money we are referring to now is called 'interest'. If you have a 'daily interest' account, the interest is paid on the smallest

amount of money you have in your account each day. The amount of money is then deposited in your account and it becomes part of the money on which the next 'interest' is calculated. In a 'regular' interest account, the interest is calculated each month on the smallest amount in your account that month. Then those (interest) sums of money are added to your account twice a year in April and October.

The best way to see the difference is to work out some problems using different amounts of money and time.

1. Would you be better off having a bank account that pays interest daily, once a month, twice a year, or yearly?

Work out the answer for #1 using the following information.

a)You put $2.00 of your allowance or earnings in the bank once a week.

b)You wait until you have saved $10.00 (hopefully, once a month) and you put it in the bank on the first banking day of the month (that way you will get the interest for a full month).

c)You put $10.00 in the bank once a month but then you take $5.00 out sometime during the month, each month.

Work out what amount you would have at the end of a year for a), b), and c) based on 6% paid each year when the interest is added to your account daily, once a month, twice a year, yearly. Try the same set of questions using different interest rates. Work out what the different amounts of interest would have to be so you would get the same amount paid to your account at the end of the year whether it was paid daily, monthly, twice a year or yearly. Work out this question again using the different percentages you used earlier.

Creating a School Bank

A group of students in Grade 8 has decided to set up a bank as their Junior Achievement Project for the year. They are still in the planning stage and have appealed for help in preparing their proposal. Their teacher has agreed to let them use the classroom from 4:00p.m. to 5:00p.m. for banking hours and the administration of the school and board have agreed to let them go ahead if their proposal is approved.

Problem One:

They have to have some shareholders in order to get 'start up' money for the bank. A shareholder agrees to put money into the enterprise and hopes to get it back when the enterprise ends. How many shareholders are needed and what sum should they each contribute? It is assumed the bank will need about $1,000.00 to start. (Let a share equal $1.00 and a shareholder must buy at least five shares.) The shareholders will share the profits or losses of the bank when it closes.

Problem Two:

The $1,000.00 startup money will be used primarily to make loans. Eleven percent (11%) will be charged on the loans and no loan can exceed one year or $100.00. If $800 is allowed to be loaned out , how much money will the bank earn in 6 months; one year.

Problem Three:

A bank needs to bring in money as well as lend it out. There will be savings accounts available that will pay six per cent (6%) per annum (about .5% more than the regular banks). Should the bank pay interest daily, monthly, or yearly? Work out the amounts the bank would pay on an account that had $35.00; $60.00; $17.50. assuming the deposits have been made at $1.00 per day; $5.00 per month until the total was arrived at. What would the difference be if half of what had been deposited during the month was withdrawn at the end of each month? (The totals at the end of the time would still be $35.00; $60.00; and $17.50). Which way of paying interest would save the bank the most money?

Problem Four:

In order to make more money, the bank has to be able to loan out the money it takes in from the savings accounts. If 12 customers deposit $1.25 per week; 9 customers deposit $1.00 per week and 11 customers deposit $1.75 per week and none of them makes withdrawals during that time, How long will it take the bank to get together another $1,000.00 to loan out? During that time the bank has paid an interest payment on the accounts, how much longer would it take if you deduct the amount of interest paid from the amount brought in by the savings accounts. (Work out the amount of interest as if it were being paid daily and deposited once a month.) Remember that interest money is also accumulating in the savings accounts and could be added to the money to be lent out. Work out the time again adding the interest money.

Problem Five:

If the bank stays in business for a whole school year, and has loaned money out at the rate of $125.00 per month at 11% per annum interest what money will be paid to each shareholder when the bank closes down in June? Will they have made a profit on their investment? (The interest money paid on Savings has to be deducted from the profits and all the loans have to be paid back within one year from the date that the bank began.)

The Elevator System

There is a job posted at the nearby mall. It is for people to deliver mail packages to different floors within a high rise office building. The office building is 20 stories high and has an elevator system. About a hundred packages are delivered to the various floors each day. Tim and Melissa have gone to see the man who is doing the hiring. He describes the work to them using a typical day as an example. They are both hired to work alternate days.

Problem One:

Tim starts the day getting a number of parcels loaded on a cart. He finds that the first parcel has to go to the 6th floor; the second parcel has to go to the 10th floor; the third parcel has to go to the 2nd floor; the fourth parcel to the 14th floor; the fifth parcel to the 8th floor; the sixth parcel to the 20th floor. (The parcels must be delivered in the order given because they have to arrive at the right time.) How many floors will Tim have visited by the time he returns to the entrance level?

Problem Two:

What would be a better way of scheduling the deliveries? How many fewer floors would be visited?

Problem Three:

It is a very busy day and it is Melissa's turn to work. There are twenty parcels to be delivered. The first parcel is for the 8th floor; the second parcel is for the 5th floor; the third parcel is for the 14th floor; the fourth parcel is for the 7th floor; the fifth parcel is for the 4th floor; the sixth is for the 13th floor; the seventh is for the 6th floor. What is the pattern that is being repeated?

Problem Four:

Repeating the pattern, how many parcels are delivered before Melissa gets back to the 5th floor? How many parcels would have been delivered by the time she got back to the ground floor?

Problem Five

Devise a pattern which will be the most economical possible (where the fewest floors will be travelled). What facts interfere with the plan? (e.g. Some parcels are RUSH and would have to be delivered immediately).

Buying Food for the School Cafeteria

Faced with rising costs, the cafeteria manager has announced she has to cut staff, some of whom have worked there many years and are well-known to the students. The class has decided to help to analyze the costs and alternatives hoping to find a way to save the jobs. She has agreed to let them try and will hold off making a decision for at least a month. Can the students show the manager other ways she can meet her cost without firing any of the cafeteria staff?

Problem One:

One of the alternatives is to save money by buying the food elsewhere. The cafeteria has been using the same suppliers for many years. There is a large discount grocery store nearby which is always having 'special' sales. If the food is bought from the discount stores will there be a saving in costs? In order to determine whether it will be cheaper or not the class will have to have the same shopping list as the cafeteria manager to make cost comparisons. She agrees to let the students have a copy of her normal weekly order so that they can compare prices she pays with what the discount store is offering. Make a table showing the costs of the items you have been given and the costs from the discount store. (The store usually produces a 'flyer' with prices for special sale items which should be available for the comparison).

An additional cost that must be included is the cost of getting the food from the discount store to the school. The normal suppliers deliver, the discount store will not. The cafeteria manager estimates her station wagon costs her about $.21 per km. The round trip to the discount store is approximately 36km. To work out any savings it will be necessary to deduct the cost of the station wagon.

Currently, the discount store has a big sale on of hot dogs, buns and frozen french fries. If each hot dog will cost $.08 less; each bun will cost $.03 less and frozen french fries will cost $.37 per kg less than on the cafeteria list and each week 150 dozen hot dog buns, 1800 hot dogs and 250kg of french fries are served. What would be the savings on

a week's supply? What would be the reduction in savings because of the cost of transporting the materials? What would be the saving if a month's supply were bought and stored in the freezer?

What other items could be added to the list of foods that are used regularly in the cafeteria for which savings could be made if they were purchased during the discount store's sales? (All information must relate to weekly costs). Use this week's advertisement from the discount store and work out how much the other items you have listed would cost if the manager bought them at the discount store. Compare those prices with the list you were given by the cafeteria manager.

Problem Two:

How much would be saved if one of the kitchen helpers was laid off? She earns $5.65 per hour and works from 9:30 A.M. until 3:45 P.M. with 30 minutes for lunch for which she is not paid. She works five days a week. How many hours a day does she work; How many hours a week does she work? What is her weekly wage for that work? In addition, she is paid 4% for statutory holidays and 4% for her regular holidays. Another 13% is put aside to cover the cost of the benefits she gets from the Board. What is the actual cost to the cafeteria per week for this employee?

Problem Three:

What would be the increase in earnings if all the menu items were increased in price by 6%? For example, a hot dog would cost $1.22 rather than $1.15; and chips and gravy would cost $.80 rather than $.75. If the numbers from Problem One are used: 1800 hot dogs are eaten per week and 1500 orders of french fries are served, what would be the amount extra the cafeteria would get as a resullt of the prices increases? Include the other items you listed in problem one that could have been bought from the discount store. If each of these items were increased 6% how much extra money would the cafeteria make?

Problem Four:

Set up a table showing the 3 sets of costs. Compare the costs from Problems One, Two and Three and determine which solution would give the cafeteria manager the highest net gain. Use the extra items you have listed in making the calculations. The manager would prefer to keep the kitchen help. If increasing the cafeteria items by 6% does not give the highest net gain, work out what percentage increase would.

Problem Five:

Get a copy of the cafeteria menu that shows all the prices. If a complete menu is not available (often the prices are just posted around the serving area), make a list of items and prices charged for those items by the cafeteria. Make a comparison list of charges for those same items at a nearby mall. (Get prices from more than one fast food place). How much more does the food cost when bought at the fast food places? What percentage more is it? Make a list of possible reasons for the higher costs. Would it still be cheaper to buy lunch at the cafeteria if the 6% increase went through?

Teacher's Guide

Introduction to the Problem Set

Advertising is a very important part of life in Canada. People with something to sell have to make the public aware of their products and of the superiority of their products over someone else's products.

Supermarkets provide an arena for the selling of large numbers of items. In order to catch the public's attention items are displayed in various ways at the end of the aisles, throughout the store, on the shelves, in the windows, etc. Some distributors even provide their own displays. All the displays, whatever their appearance, have the same aim: to sell.

What determines how an item is displayed, what is included in the display, what will attract the most attention and therefore the most sales? An analysis of the techniques employed in a local supermarket can lead to insightful discoveries.

Designing a Supermarket Display

Major Topics:

Measurement/Mensuration

Constructions

Properties of Plane Figures

Three-Dimensional Geometry

Other Topics:

Using a Table/Chart

Tabulating

Problem Solving - estimation; guessing and checking; improving the guess; accounting for all possibilities; checking for hidden assumptions; making assumptions and drawing conclusions

Integration with Other Subject Areas

Economics

Consumerism

Psychology

Report Writing

Teacher's Guide - Day 1

Teacher discusses the problem with the class as a group before students begin to work on the tasks. Do this by presenting on paper and aloud the 'Student's Version' of the problem set.

One or more periods at the beginning should be used to discuss the problem set and be sure the students know about the setting. Arrange to take the students to a local supermarket or assign as homework a trip to the supermarket. Before the trip or the assignment, discuss with them what they might expect to see at the supermarket. Spend a period or two orienting them for the trip. Discuss with them what they should be looking for (the aim is to have them look and see how displays are used to sell items). Students should be directed to pick out the display that catches their eye and explain what it was about the display that caused it to do so. The best time to start introducing the class to the problem would be on a Friday.That way the students would have the weekend to get to the supermarket and spend some time thinking and preparing a report about what they saw. The class could then start right into the discussion of the problem at the beginning of a week. A period or two might be spent talking over with the class what each student saw as eye-catching.

If this is the first time through a problem set, outline the approach: discussion, small group work, whole class, new small groups, individual assignments, evaluation methods. Stress that it is their responsibility to solve the problems, and that they should begin by asking any questions they have about how the problem will be handled.

When it seems everyone understands the setting and the task, assign students to groups of four, five or six (depending on the size of the class and the space available). Try to make each group reflect the full range of ability in the class. Try to work out the make-up of each group in advance. Do not leave a group intact that has worked together on a previous problem set. It is important to alter the make-up of the groups so that the students get experience of working with various members of the class. If this is the first

problem set to be worked and it is too early in the year for you to know your students assign them to groups using a numbering-off system determined by the size of your class, e.g. 30 in the class would give 6 groups of 5 and the numbering would be 1,2,3,4,5,1,2 etc.then all the 1's would form a group, all the 2's would form a group, etc. Be prepared to reform the groups early in the work. An unproductive group should not be left to continue.

Ask each group member to assign its membership different roles. There should be a checker, encourager, recorder, reporter, time keeper. Instruct the groups that the roles should change from time to time so everyone has a chance to take each role.

Teacher's Guide - Middle Days

After two or three periods of work in small groups during which the teacher observes and visits with each group and group member, bring all the groups back together and have the reporter from each group describe the progress made and any problems that have arisen that they have been unable to resolve within their individual groups. If difficulties have arisen because of lack of prerequisite skills and/or concepts, send them back to work on those. Teach a whole class lesson only when it is your opinion that everyone needs it. Use your judgement to decide how many times to do this (small groups to class to small groups and back to class). Some of the problems may require three or four cycles. Encourage the groups to be self-sufficient.

Whole Class Lesson Suggestions

The following is a list of objectives that may be used as didactic teaching periods or parts of periods. They are only suggestions to be followed at the teacher's discretion. They may involve teaching a whole class lesson or simply some time with students who require the help. After some encouragement, it can be left up to the students themselves to decide whether or not they 'require' the lesson. For this particular problem set, the new ideas involve constructions and 3-Dimensional Geometry. Other topics may call for review lessons.

1. Measurement and estimation
2. Constructing using 90, 60, 45 and 30 degree angles without a protractor
3. Drawing simple 3-dimensional forms
4. Relationships between 2 and 3-dimensional forms
5. Rounding and recognition of what is done with parts of objects, e.g. when the dimensions are such that there is 'part' of an object left.

Teacher's Guide - Reflection Days

The last activity when working on any problem set is the time for reflecting on the process and the outcomes. When your judgement tells you that it is time to stop, take 2-3 periods for the students to reflect a) on the problem set and notice techniques and approaches that worked for the different problems in the set, b) on their experiences working in a group, c) on their contributions to the group and to the work on the problems, d) on whether it was easier to work on this problem set (assuming they had done a previous one), and what made it easier.

If the reflection process seems to be going well, take more time to insure that what has been learned has been consolidated and that the students will be able to generalize from the experience.

Designing a Supermarket Display

Students' Version

A very important part of selling things is the display. Whether it is food, paper products or flowers, the display is meant to attract people and make them want to buy what they see. In a supermarket the manager has to make decisions about how to display an item. The attractiveness of the display may make a difference of thousands of dollars in the sales of the displayed item. Many things have to be considered by the store manager when he decides to display an item; where the display should appear, how many of the items should be displayed, whether the item should be mixed with other items, use of colour, etc. He or she must also consider the safety of the people working in the shop and the people coming to buy in the shop when the display is being designed. All supermarkets display their goods in some way or other. Some are successful, others are not.

There are a number of stores close to the school. All have displays which they use to promote special items. It is possible that they would be interested in some new ideas. To interest them in a design for a display, it will be necessary to create a scale drawing and a picture of the display. The size of the display will depend on what items will be displayed. Because of the potential danger to employees and shoppers it has been decided that no materials in metal cans or glass can be in a display more than 1.8 m high and 1.2 m wide. None of the displays can block aisles or access to the checkouts, the deli. or food bar (if there is one) and all the displays must be for inside the store.

Problem One:

To Think About

What are the different forms the displays could take? How many dimensions do these forms have?

To Do

a) How many packages of tissues would there be in a display 1.5 m high and 1.2 m wide if the packages were 20 cm x 10 cm x 10 cm? How many more could be displayed if they could be piled 2 m high?

b) How many cans would there be in a display 1.5 m high and 1.2 m wide if the cans are 15 cm x 8 cm?

c) How many cans would there be in the display if there were 3 sets of cans together with each set of cans 1 row less than the previous set?

To Think About

The displays could be different shapes. Why would some shapes be good for some containers and not for others. Which is the most useful form for display? Why?

To Do

Make a table of the different forms that could be used to display different kinds of containers, large boxes, small boxes, small cans, large cans, bottles, etc. Set up the table so that the container and the shape of the display you think would be good for it are side by side.

Problem Two:

To Think About

How would you make a drawing of a display that would show all the dimensions: height, width, depth ? Do you need to use a different kind of drawing for cans than for boxes?

To Do

Make drawings of the four displays described in Problem 1

To Think About

Rectangular containers such as cereal boxes, facial tissue boxes and detergent boxes also need to be displayed. Are boxes different than cans? How are they different? Will it be possible to make larger displays using boxes? Why? What are the important things that you need to know about the containers you are displaying?

To Do

a) Design a display for a cereal box 8 cm by 25 cm by 40 cm and make a diagram representing the design. Design a display for a 5 litre box of detergent and make a diagram to represent the display. Measure the box before you start your design. Work out how many cereal and detergent boxes you will use for your display.

b) Make a table showing the number of boxes used in the two displays designed for problem 2 including a description of the boxes used.

Problem Three

To do

a) Design a display for large cans of fruit juice (each can is approximately 23 cm high and 13 cm in diameter) to reach no higher than 1.8 metres with the base no wider than 1.2 metres. You can take up to 1.44 sq. metres of space for the base. What is the largest number of cans you could put in the space? Make a drawing showing the base of the display. Make a drawing showing the front elevation of the display. Make another display of a similar kind using small cans of soup (e.g. Campbell's regular size). Measure the cans carefully before starting to design the display.

b) Make a table showing the number of cans used with a description of the cans involved. Compare the number of items used in each display (both the box displays and the can displays).

To Think About

What other ways could the items be displayed other than from the floor up? Could they be supported in some way? Would it be reasonable to leave some of the items in their packing boxes?

To Do

Design a square supporting member for the fruit juice. Try setting up shelves which would keep each row of items separate from the others. Try staggering the number of items in a row. Would there be fewer items displayed if they were separated by shelves, or if there were different numbers of items on each shelf? If yes, how many fewer would there be a) if there were separating shelves, b) if there were different numbers of items on each shelf?

Problem Four

To Think About

Sometimes displays show more than one type of an item. For example there could be a display of two or three kinds of fruit juice made by the same manufacturer. Would having to display more than one kind at the same time create new problems? What would those problems be?

To Do

Design a display using large cans (see Problem Three) of three different kinds of fruit juice in such a way that a customer can see that there are three different fruit juices on display. Make a drawing (not a diagram) of your display using a straight edge and set square. Colour the cans with different colours to show the three kinds of juices displayed.

To Think About

Many things are packaged in bottles. How could bottles be displayed? Are the problems of displaying bottles different than the problems with cans? How would you display bottles that have long necks, that bulge in the middle, that are odd shapes?

To Do

Design a display using 1.5 litre bottles of pickles. This display will have to be within the 1.8 m height limit too, because of the weight of the bottles and the potential danger of them hurting someone if they fell. Measure the bottles carefully before making a drawing of them. In some cases the bottles bulge out in the middle and take up more room than either the top or bottom of the bottle would indicate. Make a drawing of this display, too.

Problem Five

To Think About

A decision has to be made by the whole class as to what design will be presented to the supermarket. What criteria should be used for making that choice? How will the selection be made so the class presents the design all groups agree will be their best effort?

To Do

Prepare a list of criteria you think are important. Share your criteria with the other groups in the class. When all groups agree to the criteria then have a whole class judging of what design best fits those criteria.

Installing Solar Panels for the School

Energy conservation is an important problem which many people are concerned about. There are many ways to conserve energy. There are often programmes on T.V.,and radio or articles in the newspapers and magazines demonstrating how to do it. How do we know we are conserving energy? One way of conserving energy isto use a renewable source rather than a non-renewable source, e.g. energy from the sun rather than from fossil fuels. With this in mind the school board has decided to install solar panels on this school so that the sun's energy can be used to make the school's hot water supply. Before the board goes ahead with its plan, it wants to be sure that energy and money will be saved.

Problem One:

Are there enough hours of sunlight to provide the energy needed to heat the water? (There are meters which can measure the time from dawn to dusk. The information is readily available everyday in the newspapers. It is used to determine the hours that a vehicle must have its lights on while in transit.) What are the 'high' light periods of the day, month, year? How much energy will be needed?

Problem Two:

How many litres of hot water are used per day in the school? Does the consumption vary from day to day; season to season? Is more hot water used in the winter than in the summer? What does it cost to heat the water, now? What did it cost last year to heat the water? What has been the 'average' cost per year for the last five years? Work out future costs using a 3%, 4%, and 5% inflation figure.(Assume that the consumption stays the same.)

Problem Three:

How many solar panels are needed to provide the amount of hot water needed? (Ask the manufacturer). How much piping would be needed to circulate the water from the solar panels to their places of use in the school?

Problem Four:

What would be the cost of installing the system? How long would it take to get back the cost of the installation? (Use the information from Problem Two.) Divide the average cost per year for heating the water over the next five years using the inflation factors from Problem Two into the cost of a working system of solar panels. The answer is the number of years it takes before there is any savings in money from the cost of the installation.

Problem Five:

What problems need to be considered before locating the panels? (protection of the panels from vandals, weather, shadows, animals, etc.; length of piping) Why should the solar panels be located where there will be fewest shadows? Where should the panels be located?

Teacher's Guide

Street Versus School Mathematics: Is there a Difference?

Have the students work through through the problems using the mathematics that the candy sellers had to use. The candy sellers were able to identify each and every bill in their currency either by the number or colour or picture on the bill. Addition and subtraction would be done by grouping similar numbers i.e. If there were a pile of different denominations, the child would separate them into same denominations and then count them up. They would also know how many of one denomination there is in another bill.

Explain words such as inflation, average, current, profit, currency, denominations of bills.

Do the above problems using standard mathematical procedures.

Have the children consult a current list of foreign exchange for Brazil, Mexico and Guatemala and work out how many units of their money equals $1.00 of ours. What is the average wage for each of those countries? Compare their average annual wage with a Canadian average wage.

Street Versus School Mathematics:Is there a difference?

Pupil's Guide

In third world countries, such as Brazil, young children support themselves and /or their families by selling candy in the streets of the cities and towns. Few of them get a chance to go to school yet they are able to make change and decide what to charge for their candy by recognizing the different denominations of money available and using a simplified form of counting.

Problem One:

What currency is used in Brazil? How many different forms does it take (1,000, 2,000, etc)? What information would a candy seller need to have?

Problem Two:

What could alter the amount of money a candy seller would charge for the candy (e.g. what others are charging, inflation,etc.)?

Problem Three:

Work out what the candy seller would have to charge in order to cover his costs and have some money left over for him/herself. In order to do so, you must first decide what it will cost to buy boxes of the candies that will be sold on the streets. The boxes of candy are bought from a wholesaler.

Problem Four

What was the rate of inflation in Brazil this year? What was it last year? What was it in 1986? If a box of candy sold for Cr $200 in 1986. Calculate how much the price would have had to increase each year so the wholesaler would get approximately the same value for the candy. How much would each piece of candy the child sells have to be increased in price by 1989 in order to give the same amount of profit. What would be the current price for a piece of candy?

Problem Five

What is the average income in Brazil? How much has it increased since 1986? What is the relation between the current inflation rate and the average income? Has the average income increased as much as the inflation rate? How is the candysellers' costs altered by inflation?

Locating a School
in a
New Community

Grpahics for this problem set were overlooked when preparing the final report, and only rough drafts were available. The problem set will be supplied if requested.

Finding out What's in Things

This problem set was developed for Grade 7 by Fiona White, a student at OISE and Department Head in Port Hope. It is based on the optional unit, "Chemicals", from the new Intermediate Science Guidelines (1987). It was still in use as of the preparation of this final report. It can also be supplied later if requested.

VIDEOTAPE

The Inductive Curriculum:
Integrated Teaching and Learning
for the Middle School

(provisional title)

The classroom scenes are on tape, with graphics, titles and editing in progress. The finished tape (approximately 25 minutes) will be ready by September 1 at the latest. The tape is designed to communicate the principles of the *Inductive Curriculum*, illustrate how they are applied in the classroom and call attention to both advantages and to aspects that are difficult to implement. The target audience is teachers, and the purpose is to inform and to motivate them to read the printed material giving lots of details. It will also be useful to show to Principals and Consultants, and it could be used at a Home and School meeting after a school decided to implement the approach in several classrooms.